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The ILLUMINATING ENGINEER

Edited by

LEON GASTER

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EDITORIAL.

Progress in the Past Year.

It is our custom to present in the January issue a review of progress during the past year. Two years have now elapsed since the signing of the Armistice, and while the War has naturally left various economic and other difficulties in its train, considerable progress has been made towards more normal conditions in the lighting industry. It will be convenient to follow the same procedure as that adopted on similar occasions in the past, and to review firstly developments in lamps, lighting appliances and measuring instruments, and secondly, their applications in practice. Developments in this country are summarised in the various reports presented at the opening meeting of the Illuminating Engineering Society on 14th Dec., reported in this issue (pp. 7–14). Reference may also be made to the Report of Progress presented at the last convention of the American Illuminating Engineering Society, which contains a comprehensive review of conditions in the United States, and refers to various developments in Europe. Speaking generally, manufacturers have been engaged mainly in improving their facilities for producing standard articles. It is to be hoped that a reduction in price of lamps and fittings will follow as a consequence of these improvements in processes and better methods of standardisation.

Progress in Lamps and Lighting Appliances.

Makers of electric lamps in this country record that facilities for meeting demands in lamps and lighting fittings have improved considerably. The chief development has been the introduction in this country of small consumption gas-filled lamps. A caution may be given against the indiscriminate use of such lamps without proper shades and reflectors, and, fortunately, the supply of such appliances seems to be improving. One development that should prove useful in this direction is the introduction of small gas-filled lamps with opal glass bulbs, whereby the light is diffused and the glare materially diminished. We think, however, that, when used at close quarters, even this form of lamp should be equipped with a suitable shade. Supplies of gas-filled lamps are stated to have increased about five times. In the United States the production of lamps continues to rise, the figure of 230,000,000* (excluding miniature types, which approached 125,000,000 per annum) being attained for 1920. It is to be noted that carbon filament lamps now form only about 7 per cent. of the total.

Much interest was excited at the last meeting of the Illuminating Engineering Society by the exhibition of two small neon lamps, capable of being inserted direct into an ordinary lamp socket on 220 volts. Such lamps open a promising field of further experiment, and may already have useful applications for certain forms of work (*e.g.*, as luminous signs, signals, etc.).

A feature in the United States has been the rapid extension of the uses of miniature glow lamps, largely for automobile headlights, but also for many special purposes (special lamps for dentists and medical use, portable cinema outfits, etc.). The electric miners' lamp appears to be developing favourably in the United States; and in this country the discussion before the Illuminating Engineering Society in February emphasised the importance of improved lighting in mines with a view to checking the development of miners' nystagmus. Portable flashlight lamps are finding many applications. A form of apparatus developed in the United States utilises a small hand-driven magneto to supply current to the lamp, in place of the customary dry battery.

In the field of gas lighting, while no very striking developments have occurred, there have been modifications in the design of burners, shades, etc., one interesting departure being the use of special silica-glass "intensifiers," which can be placed quite close to the mantle, thus aiding in the diffusing of light and, it is stated, considerably increasing the efficiency. The Gas Regulation Act, and the step contemplated by many companies and already carried out by some, of supplying gas on a purely calorific basis, is naturally of great interest, and may give rise to some special problems in gas-lighting. One point already being discussed is the adaptation of burners to various qualities of gas.

Of developments applying to all illuminants attention may be drawn to the growing interest in methods of producing artificial daylight, illustrated by the demonstration of the "Sheringham Daylight," which we understand

* *Gen. Elec. Rev.*, U.S.A., Jan., 1921.

is now being made in a small portable form and which it is hoped to apply to incandescent gas as well as electric lamps. There seems no reason why the same methods should not be applied to other illuminants. In view of the variety of appliances now coming into use for producing "artificial daylight," the best method of comparing the spectra of these illuminants, in order to ascertain the degree of exactness of their imitation of daylight, requires careful study.

Photometry and Apparatus for Measuring Illumination.

While there have been few striking developments in photometric apparatus, the field for the use of illumination photometers is steadily increasing, and the time has come when a thorough investigation into the accuracy desirable and attainable with such instruments is much needed. This subject, amongst others, will receive attention from the newly constituted Standing Committee on Photometry and Allied Subjects, formed by the Illuminating Engineering Society in this country. One tendency is towards the production of simple forms of apparatus such as can be read by the inspection of a scale without manipulation to obtain photometric balance. An example of this form of instrument is the foot-candle meter shown at the last meeting of the Society (see p. 15). Interesting researches, mainly utilising the globe photometer, have been undertaken on the absolute co-efficients of reflection of various materials—a subject of great scientific and practical importance.

Opportunities for Research in Illuminating Engineering.

While it is impossible to do more than summarise very briefly some of the chief developments in illumination engineering during the past year, a few examples may be mentioned of problems raised at recent meetings of the Society, all offering fruitful fields for further research.

Thus the discussion on Lighting Conditions in Mines in February last has shown the need for further investigations into the relation between conditions of illumination and miners' nystagmus, and the subsequent discussion in March on motor-car headlights has already led to the formation of a Joint Committee to inquire further into this subject. The Society also embarked last year on a new field in connection with cinema work. The Joint Committee reported last year to the London County Council on the subject of Eyestrain in Cinema Theatres. Following the Annual Meeting there was a discussion, opened by Captain J. W. Barber, on Portable Types of Cinema Outfits, while in January of the present year attention is to be devoted to the lighting of cinema studios.

Among other fields of work, we need only mention the vast field of industrial lighting. The important first Congress of the British Industrial Safety First Association, in co-operation with the Home Office, held at Olympia last September, illustrated the importance now attached to good factory lighting in the interests of health, safety, and efficiency—a subject which is also to receive attention from the Industrial Hygiene Section of the International Labour Office of the League of Nations at Geneva. In America several States have been added to the list of those issuing codes of industrial lighting during the past year, and in this country the Departmental (Home Office) Committee on Lighting in Factories and Workshops has resumed its operations, temporarily suspended during the War.

National Economy and Scientific Research.

The peculiar conditions arising in this country during the War had at least one beneficial influence, namely, in stimulating a general recognition of the importance of technical education and scientific research. In referring to the matter at that time we expressed the hope that this more enlightened attitude would be permanent, and that after the War the ground gained would be solidified by steady effort. Experience teaches that countries can only derive substantial benefit from research and education when both continue to be developed for a period of years. Intermittent interest, great plans, hastily adopted and as suddenly dropped, are fruitless.

We recall this warning, because at the present time there is a danger that, either through indifference, or through mistaken conceptions of economy, many of the lessons of the War may be lost. There was never more need for the claims of scientific and industrial research to be kept before the public and official mind, and Mr. A. Abbott's paper on " Industrial Research Association " before the Royal Society of Arts, on 26th Jan., was therefore most timely. In this paper Mr. Abbott traced the progress of the Department for Scientific and Industrial Research—one of the most important efforts born of the newly-kindled appreciation of science during the War. It has been remarked that the industrial lead originally gained by this country was largely the result of economic stability, and of geographical and other advantages, but that it has lost ground by its neglect, in comparison with other countries, of education and research. Dealing with the formation of industrial research associations in this country, Mr. Abbott remarked that " epoch-making inventions cannot now be made by unlearned men, working alone and with slender means." To-day research requires organised, adequately-sustained effort.

There can be no question that the formation of the Department, and the initiation of the many researches with which it is indirectly or directly associated, has had a most beneficial influence. Fortunately, it was recognised at an early stage that many researches of great ultimate benefit to the country and yet not offering immediate financial return, cannot be pursued by private individuals unaided. It accordingly made grants to suitably constituted Research Boards, a number of which are actively at work, some directly responsible to the Department, others also working in co-operation with other Government departments or scientific bodies.

At the present moment there is a danger that the general appeal for economy may exercise a prejudicial effect on some of these researches—may even terminate them entirely. Among the researches thus threatened are some of such a nature that their full value can only be secured by continuity of work over a number of years. We are well aware of the need for retrenchment following the vast expenditure during the War. But one could scarcely imagine a more misguided effort at economy than the termination of scientific researches which, while only involving small expenditure, promise a useful practical return. Moreover, in some of these cases a stoppage of work at this stage would mean the sacrifice of the results of years of effort. The amount spent on research in this country is still ludicrously small in comparison with that expended on the Continent and in the United States, and it is to be hoped that scientific bodies will make every effort to prevent a relapse into the pre-War indifference to education and research, and will urge the Government to contribute the necessary financial support.

LEON GASTER.

TRANSACTIONS

OF

The Illuminating Engineering Society

(Founded in London, 1909.)

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

RECENT DEVELOPMENTS IN ILLUMINATING ENGINEERING.

(Proceedings at the opening meeting of the Illuminating Engineering Society, held at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C., at 8 p.m., on Tuesday, December 14th, 1920.)

THE opening meeting of the session was held at the House of the Royal Society of Arts on Tuesday, December 14th, 1920, the Chair being taken by Dr. A. H. LEVY.

The Minutes of the last meeting having been taken as read the HON. SECRETARY presented the following names of new applicants for membership :—

Ordinary Members—

Dickson, Lieut. A. G. ..	Electrical Engineer, No. 2, Electrical and Mechanical Co., BAGHDAD.
Foster, H. LL. T.	Chief Electrical Engineer, British Engine Boiler and Electrical Insurance Co., Ltd., 25, Carlton Hill, LONDON, N.W.8.
Fraser, Stewart	Superintendent of Lighting, Egyptian State Railways, Avenue Nubar, HELIOPOLIS, Egypt.
Garrard, Major A.	Civil Servant, 104, Tennyson Road, LUTON, Beds.
Kirk, A.	Electrical Quantity Surveyor, 14, Victoria Street, LONDON, S.W.1.
Weston, H. Claude	Investigator to the Industrial Fatigue Research Board, 103, Kilmartin Avenue, Norbury, LONDON, S.W.16.

The HON. SECRETARY also read out again the names of applicants for membership presented at the last meeting, on May 11th, 1920, and these gentlemen were formally declared members of the Society.*

The HON. SECRETARY (Mr. L. GASTER) then presented the customary **Notes on Events during the Vacation.** He referred to the formation of several new committees, dealing respectively with the Measurement of Light and Illumination Glare from Motor-Car Headlights, and Progress in Gas Lamps and Lighting Appliances, and recalled that a report has been recently presented to the

* ILLUM. ENG., June, 1920, p. 173.

London County Council by the Joint Committee on Eyestrain in Cinemas. By its participation in the Congress of the Royal Society of Public Health, held in Brussels this year, the Society had resumed its customary practice of co-operating in international gatherings concerned with illumination. Great interest had been taken in the subject of industrial lighting. There were now six American States which possessed legislative codes on factory lighting. Industrial lighting in the interests of safety formed an important feature at the first conference of the recent British Industrial "Safety First" Association at Olympia, and a number of lectures and papers had recently been delivered dealing with this subject.

Mr. J. W. ELLIOTT then presented the report of the Committee on **Progress in Electric Lamps and Lighting Appliances.** A feature of the past twelve months had been the extension in the production of incandescent lamps, and the difficulties referred to in the report of the previous year had been largely overcome. The production of gas-filled lamps had increased five to six times, and the range had been extended by the introduction of 40 watt 100—130 volt and 60 watt 200—260 volt types. Small shades and bowls for use with such lamps had recently been introduced.

The ASSISTANT HON. SECRETARY (Mr. J. S. Dow) then presented the Report of the Committee on Progress in Gas Lamps and Lighting Appliances, in the absence of the Chairman of the Committee, Mr. Bridger. The report mentioned recent improvements in efficiency of low pressure lamps following the application of the superheating principles to a number of small burners. Manufacturers were endeavouring to secure standardisation in sizes of glassware. In view of the fact that gas was the illuminant of the poorer classes the Committee viewed with anxiety the restriction of importation of mantles and illuminating glassware.

Mr. STAINES of the Edison Swan Electric Co., Ltd., then exhibited some small **gas-filled ("Fullalite") lamps, equipped with opal bulbs** whereby the filament was completely screened and the light diffused uniformly over the bulb.

Mr. J. S. Dow exhibited several **small neon lamps,** lent for exhibition by the Edison Swan Electric Co., Ltd., which could be used in an ordinary lamp socket on a 220 volt supply and consumed only 5 watts each. The light was derived from an electrical discharge in neon gas, and though the candlepower was at present low, the lamps seemed to have useful applications for luminous signs and other special purposes.

Mr. Dow also exhibited a **new form of "foot-candle meter"** lent by the British Thomson-Houston Co., Ltd., the feature of which was that values of illumination could be read off by the inspection of a series of translucent illuminated spots, without its being necessary to manipulate the instrument in order to obtain balance.

Major ADRIAN KLEIN then gave a demonstration of the latest type of **Sheringham Daylight,** explaining the steps that had been taken to obtain a matt and permanent coloured surface, and summarising developments that had taken place since the apparatus was first shown last year. He mentioned that a portable form of table lamp was being produced, and that it was proposed to apply the method to obtain "artificial daylight" from incandescent gas lamps.

Mr. A. CUNNINGTON then showed a lantern slide illustrating the method of lighting railway time tables at Waterloo Station by means of transmitted light. The lighting was effected by placing lamps inside the rack which carried time tables attached to sheets of glass. The illumination was ample, and the objection attaching to extraneous lighting, that inconvenient shadows were apt to be cast by the bodies of observers, was eliminated.

A short discussion followed, at the conclusion of which a vote of thanks to exhibitors and speakers was passed. It was announced that the **next meeting** of the Society would be held on **Tuesday, January 18th,** when a discussion on **"The Application of Light in Film Production** with special reference to the **Lighting of Cinema Studios"** would be opened by Mr. J. C. ELVY.

In closing the proceedings the Chairman also announced that Mr. J. HERBERT PARSONS, C.B.E., F.R.C.S., had been elected **President** of the Society.

NOTES ON EVENTS DURING THE VACATION.

By L. Gaster (*Hon. Secretary*).

(Presented at the meeting of the Illuminating Engineering Society held at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C., at 8 p.m., on Tuesday, December 14th, 1920.)

It is customary at the first meeting of the session to give some account of progress during the vacation.

The arrangement whereby the Presidents of kindred bodies become Members of Council of the Society during their tenure of office has now been extended to include the Society of British Gas Industries, and the institutions and associations adopting this arrangement now include :—

The Illuminating Engineering Society in the United States; the Illuminating Engineering Society in Japan; the Institution of Gas Engineers; the Institution of Electrical Engineers; the Council of British Ophthalmologists; the Ophthalmological Society; the Physiological Society; the Electrical Contractors' Association; the Society of British Gas Industries; and the Association of Railway Electrical and Telegraph Engineers.

The co-operation of these various bodies continues to be of great service in dealing with problems of mutual interest.

Progress has been made by the Illuminating Engineering Society in Japan, on which some information was afforded by Prof. Yamakawa, the first President, during his recent visit to this country. On his return to Japan, Prof. Yamakawa made known the work of the Illuminating Engineering Society in this country, and a full account of its activities, printed in English, has since appeared in the transactions of the Japanese Illuminating Engineering Society. Attention having been drawn to the fact that papers read in Japan are commonly not accessible to readers in this country by reason of their being printed in Japanese, the question of providing abstracts in English has been considered, and a summary of one recent paper has already been furnished. This practice will naturally aid in facilitating interchange of views and co-operation between the societies in this country and Japan.

The National Illumination Committee has been continuing its useful work, and is now engaged in preparing a series of definitions of the chief terms used in illuminating engineering. It is suggested that a meeting of the International Illumination Commission should be held in Paris next year, when various technical questions will be discussed. It is hoped that the subject of industrial lighting will receive special attention, with a view to international action.

I regret to record the deaths of two members of the Society—Mr. G. O. Light, who acted as Honorary Solicitor since its commencement, and Dr. W. P. Nuël, of Liège, who, as a corresponding member, had assisted the Society in obtaining information on various problems relating to the effect of light on vision, notably in connection with miners' nystagmus.

The various committees of the Society have been actively continuing their work. An Interim Report was furnished to the London County Council by the Joint Committee on Eyestrain in Cinemas last June, and has since been published, by the permission of the L.C.C., in the official organ of the Society. It is proposed that this Committee should continue to act as a permanent source of information to which questions relating to lighting conditions and matters affecting the comfort of the eyes in cinema theatres, studios, etc., can be referred. The alleged prejudicial effect on the eyes of cinema actors of the powerful lights used in some studios during the preparation of films has recently been brought to our notice, and it has been suggested that this matter should also receive attention from the Society.

The Committee on Progress in Electric Lamps and Lighting Appliances, formed last year, has issued its usual annual report of progress in this field, and a similar committee to deal with Progress in Gas Lamps and Lighting Appliances (burners, mantles, glassware, fittings, etc.) has now been formed by the Society of British Gas Industries to co-operate with our Society. The members of this Committee, as at present constituted, are: Mr. J. Bridger (Chairman), Mr. F. J. Gould, Mr. G. Hands, Mr. W. Mattock, and Mr. F. C. Tilley (Secretary); but provision has been made for its extension by the nomination of additional representatives if deemed necessary. It is hoped that the work of this Committee will be useful in establishing the best methods of utilising gas for lighting, and in keeping the Society informed of the latest developments.

It will be recalled that, at the conclusion of the discussion on "Motor-Car Headlights and Rearlights in relation to Traffic Requirements," opened by Mr. J. W. T. Walsh, at the meeting of the Society on March 30th, a number of problems were mentioned as requiring further investigation. The Society has accordingly formed a Joint Committee to deal with this subject, on which the following bodies are so far represented :—

The Illuminating Engineering Society, the Research Association of British Motor and Allied Manufacturers, the Royal Automobile Club, the Institution of Automobile Engineers, the British Scientific Instrument Research Association, the Commercial Motor Users' Association, and the Electric Lamp Manufacturers' Association of Great Britain, Ltd., the Council of British Ophthalmologists, and the Physiological Society.

It is hoped that this Committee, like the Committee devoted to Eyestrain in Cinemas, will serve a representative body by whom systematic researches can be conducted and to whom all problems relating to motor-car headlights in relation to traffic may be referred.

During recent years there has been a growing demand for measurements of illumination in various fields of illuminating engineering, notably in connection with the lighting of streets, factories, etc., and a great variety of instruments for this purpose are becoming available. It was accordingly felt that the time was ripe for the formation of a Committee, composed of members of the Society, who are experts in photometry, to deal with outstanding problems connected with the degree of accuracy and methods of use of illumination-photometers. A Committee has therefore been formed, including Mr. A. Blok, Mr. J. G. Clark, Mr. W. C. Clinton, Mr. J. S. Dow, Mr. K. Edgecumbe, Mr. L. Gaster, Mr. Haydn T. Harrison, Mr. W. J. Liberty, Prof. J. T. McGregor Morris, Mr. A. Stokes, and Mr. A. P. Trotter. In view of the Society being regarded as the leading authority on such matters it is hoped that the Committee will prove of value as a source to which any questions that may arise in connection with contracts or legislative recommendations involving the provision of a specified candlepower or illumination, may be referred.

The subject of industrial lighting has been receiving special attention, both in this country and in the United States, where there are now six States that possess legislative codes on lighting in factories and workshops. The most recent State to adopt such legislation, Oregon, has issued a code which contains some interesting features. One point strongly emphasised is that the mere provision of sufficient illumination will not answer unless due regard is paid to other recommendations on the subject of glare, avoidance of inconvenient shadows, etc. Accordingly, in the official bulletin explaining the code, the summary of illumination values is placed at the end, following the recommendations on glare, shadows, etc.

Prior to the War industrial lighting was frequently the subject of discussion at international conferences. It is gratifying to report that this procedure was renewed at the Congress of the Royal Institute of Public Health held in Brussels during May 19th—24th, at which the writer had the pleasure of reading a paper on Industrial Lighting.

Another subject which was treated in several papers at this congress was the origin of miners' nystagmus, which

had previously been dealt with in a discussion before the Illuminating Engineering Society in February. There is a growing recognition that industrial lighting should be dealt with on an international basis, the fundamental principles of good lighting in factories and workshops being broadly similar throughout the world. This question is now to receive attention from the Section of Industrial Hygiene of the International Labour Office established by the League of Nations at Geneva. With this section, Professor L. Carozzi, a valued corresponding member of the Society, is associated.

Lighting in factories and workshops, as an aid to safety, also figures largely at the first conference organised by the British Industrial Safety First Association at Olympia on September 22nd, when a paper on "Lighting as an Aid to Safety" was read by the author. The importance of the occasion was marked by the fact that the Home Secretary consented to preside during the morning session, while in the afternoon the chair was taken by Lord Leverhulme—an arrangement which aptly illustrated the cordial support which the movement receives both in official quarters and in the industrial field. The proceedings were opened by an introductory address by Mr. G. Bellhouse, C.B.E. (H.M. Deputy Chief Inspector of Factories), and in the series of papers read frequent references were made to the part played by good illumination as an aid to safety.

There have been a number of reports and papers read before various bodies dealing with industrial lighting. A report of considerable interest, showing the relation between illumination and output in the silk-weaving industry, has been issued by the Industrial Fatigue Research Board, and frequent references to lighting were made in the Annual Report of H.M. Chief Inspector of Factories.

Papers dealing largely with industrial lighting have been read by the authors before the Association of Engineers in Charge, and the London Association of Foremen Engineers—both bodies which could do a great deal to assist the study of proper conditions of lighting in factories.

In conclusion it is interesting to observe that a Committee dealing with the Causation of Blindness and Defective Vision has recently been formed under the Ministry of Health. Doubtless, the part played by incorrect methods of lighting in causing defects of vision (notably in connection with the prevalence of miners' nystagmus) will receive the sympathetic attention of this Committee, which includes several eminent ophthalmic surgeons familiar with this aspect of the subject.

MR. J. HERBERT PARSONS, C.B.E., F.R.C.S.,

The New President of the Illuminating Engineering Society.

We have pleasure in recording that Mr. J. Herbert Parsons, C.B.E., F.R.C.S., has been unanimously elected President of the Illuminating Engineering Society in succession to Mr. A. P. Trotter.

As the first Chairman of Council of the Society, Mr. Parsons has been closely identified with its work from the earliest stages, and has taken part in many discussions bearing on the effect of light on the eye. Mr. Parsons is a member of many Departmental and other committees interested in various aspects of illumination in relation to vision. Many of the problems now engaging the attention of the Society require for their solution the co-operation of the physiologist and the ophthalmologist, and the Society is therefore to be congratulated on a very suitable choice for its president during the present session.

THE POSITION OF THE METAL FILAMENT LAMP AND FITTINGS INDUSTRY AT THE PRESENT TIME.

(Report of the Committee on Progress in Electric Lamps and Lighting Appliances [Mr. S. H. Callow (Chairman), Mr. J. E. Edgecombe, Mr. J. W. Elliott (Secretary), Mr. J. Y. Fletcher and Mr. F. W. Willcox]; presented at the meeting of the Society held at the House of the Royal Society of Arts, at 8 p.m., on December 14th, 1920.)

We have pleasure in reporting that the manufacturers of electric lamps have, during the past twelve months, given considerable attention to extension of works and improvements in manufacture for the larger production of lamps to meet what they considered would be an increasing demand.

They anticipate that this increasing demand will be brought about due to the large number of prospective consumers who have been waiting for the supply companies to connect them to their mains, and also by the completion of the new Housing Scheme, as many of these houses will be electrically lighted.

The demand for vacuum type lamps can now be met for all standard types, and in most cases adequate stocks are available to meet the increased demand due to the cessation of Summer Time. The greatly increased production of such lamps is already emphasised by the fact that there is evidence of real development in the exportation of electric lamps abroad, particularly to the British Colonies.

The difficulties, mentioned in our last report, which previously handicapped the manufacturers, such as the shortage of bulbs and tubing and also the poor quality of same, have now been very largely overcome by the increased production of such material in this country.

As regards the supplies of gas-filled lamps, the production has increased five or six times during the last twelve months, and the demand for most of the standard sizes can now be met.

Most of the leading manufacturers are rapidly extending their production still further, and it is hoped that within a few months the supply will equal the demand for all types.

In July last the range of gas-filled lamps was extended by the introduction of two new sizes, *i.e.*, 100 to 130 volt, 40 watt, and 200 to 260 volt, 60 watt.

From the demand for such lamps already experienced during the short time these new sizes have been on the market, the manufacturers are led to believe that the public are gradually becoming educated to an all-round higher standard of illumination, which, particularly in the case of industrial service, leads generally to the increased comfort of the worker with a corresponding higher standard of production.

During the past twelve months the manufacturers have again been able to give their attention to the production of metal filament lamps for special purposes, such as standard candle lamps, double-ended tubular lamps for window and cornice lighting, and various patterns of reflector type lamps. Such special lamps can now be obtained in any of the standard voltages and wattages without undue delay.

Fittings.—In our previous report we admitted that there was very little variety in the way of scientifically designed fittings or reflectors for use with gas-filled lamps. We are pleased to state, however, that during the past twelve months the principal manufacturers have introduced a range of suitable fittings to suit all voltages for which such fittings are required, *i.e.*, street lighting, works lighting, the lighting of railway termini or other large areas, and also shop-window lighting. They have also introduced a variety of small shades and bowls for use in connection with the lower wattages of gas-filled lamps, which meet a very real need for shop-window lighting and the lighting of small areas. By this means the light of the efficient gas-filled lamp is distributed in the right direction, and all glare eliminated.

S. H. Callow
(*Chairman*).

J. W. Elliott
(*Secretary*).

PROGRESS IN GAS LAMPS AND LIGHTING APPLIANCES.

(Report by the Committee on Progress in Gas Lamps and Lighting Appliances [Mr. J. Bridger (Chairman), Mr. F. J. Gould, Mr. G. Hands, Mr. W. Mattock, Mr. F. C. Tilley (Secretary)], presented at the meeting held at the House of the Royal Society of Arts, 18, John Street, Adelphi, W.C., at 8 p.m., on Tuesday, December 14th, 1920.)

RECENT improvements have been principally directed to increasing the efficiency in candlepower of both outdoor and indoor high power low pressure lamps on the superheated principle by using a multiple of small burners (which dispenses with the need for inner glass cylinders), thereby reducing the cost of maintenance, which is especially important owing to the present high cost of illuminating glassware. These improvements are appreciated by Gas Undertakings as also consumers.

Standardisation is being carried out by manufacturers as far as possible in regard to the sizes of glassware.

With regard to the effect on gas lamps and burners caused by the introduction of methods specifying calorific value this is being met by giving a larger range of gas regulation and air adjustment, so that no differences should arise excepting under some conditions where lamps and burners are already installed. In most cases these lamps and burners can be made to act satisfactorily by slight alterations, but to make burners without air and gas adjustment is not practicable excepting for places where an even pressure is maintained.

The Committee views with very considerable anxiety the present inadequate supply and great cost of glassware and high cost of mantles, and is of opinion that should these essentials be made " Key industries " the prohibition of their importation will place the Gas Lighting Industry in an extremely serious position. Gas is the illuminant of the poorer classes, and this fact alone should be sufficient for the Government to see that traders in the Gas Lighting Industry should not be hampered by any restriction with regard to importation of either mantles or illuminating glassware. Otherwise they will be penalising the very class of the community they particularly wish to protect, as incandescent gas lighting is essential to them.

J. BRIDGER (*Chairman*).

EXHIBITS ILLUSTRATING PROGRESS IN ILLUMINATION.

SMALL GAS-FILLED ("FULLALITE") LAMPS WITH OPAL BULBS.

THE first item amongst the exhibits was a demonstration by Mr. Staines, of the Edison Swan Electric Lamp Co., Ltd., of some small gas-filled lamps with opal glass bulbs. In these lamps the filament is completely screened, and the light is spread evenly over the bulb-surface. In the 60 watt lamp, Mr. Staines pointed out, there was almost total diffusion. These special lamps were made in sizes up to 200 watts. There seemed no object in applying the method to the larger sizes. Even with an opal glass bulb it was usually desirable to employ a reflector, so as to concentrate the light downwards; but if no shade was used the effect was much better than with a clear bulb, owing to the elimination of glare and pleasing effect of the diffused light. The 40 watt lamp was at present only made for the lower range of voltage (100-130 volts), but it gave quite sufficient light to enable people to read in comfort, even supposing that no shade was used.

DEVELOPMENTS IN THE SHERINGHAM DAYLIGHT.

MAJOR A. KLEIN recalled that when the Sheringham Daylight was last shown to the Society the apparatus was in an experimental form, for it consisted in a metal conical shade upon which was mounted a paper lining, coloured by hand with the necessary pigments in a simple pattern in the required proportions. Since that time, not a year ago, the problem of production on a commercial scale had been solved successfully, not, however, without encountering a number of quite extraordinarily difficult technical problems. There were four requirements which had to be met with regard to the coloured surface upon which the whole effect depended, namely:—(1) the colour must be matt. (2) It must remain unaffected by the great heat generated by the high power lamp. (3) The colours must be permanent to light. (4) The coloured surface must be washable. They found at first that they could fulfil perhaps two of the conditions, but never all four together, and, as a matter of fact, there existed as far as their researches led them no medium with which to mix pigments possessing the four qualifications. Oils and varnishes seriously affected the purity of the blue and were easily affected by heat. Various spirit and tempera albumen or distemper mediums experimented with dulled or otherwise affected the blue. The original blue was water colour, in which there was always a certain amount of gum, not affecting the colour to a great extent, but being instantly removed by water. Finally the difficulty was solved by the discovery by a dye chemist of a medium possessing remarkable characteristics. The pigment dried with a matt surface, the colour being nearer the brilliant purity of hue shown by the virgin powder than had been obtained by any method previously used, a discovery in fact of no little importance to the art of painting. But this was, of course, not their immediate concern. This medium was unaffected by any heat likely to be encountered, and, having dried, was not subject to change by oxidation, change of atmosphere, atmospheric pollution and other usual causes of disintegration of paint mediums. The surface could be cleaned by lightly sponging. Some mediums fulfilled the latter conditions, but failed as regards purity of the colour and had other defects. The new medium seemed to fulfil all the necessary requirements. The pigments used were permanent to light.

The arrangement of the colours in the form of a pattern with each colour element in a certain proportional area had been attained by superimposing perforated zinc upon sheets of asbestos. Thus a pattern of blue and green was simply formed. The lining of perforated zinc and asbestos was held in position by metal strips radiating from the centre, and these were bolted to the shade, the inside of the bolt holding a circular washer of fibre. The bolt head and washer were coloured red, thus accounting for the third element in the coloured reflecting surface. An inverted cone has been added to the interior of the shade, and this has been found to aid in the general diffusion of the light.

The industrial unit exhibited consisted of a conical metal shade, enamelled on the outside, fitted with focussing top, internal diffusing cone, metal under-reflector with chains for attaching to the shade, lampholder with cord grip, and hooks for three point suspension. The interior coloured lining could be easily removed for renewal or cleaning. The silvered lamp had been given up, chiefly because they were not a stock article, and were difficult to make satisfactorily. In its place a nickel plated bowl was used. It was hoped later to adopt a bowl with a lining of cobalt plate, the reflection from polished electroplated cobalt is in many respects superior to nickel or silver.

The perfection of the colouring process has made a marked improvement in the correction of the light, and he hoped at a later date to present curves illustrating the present results. The reflection of the shorter wave lengths was greater and the visual appearance of the light consequently whiter and a nearer approach to the north light approximate standard. Whereas this extreme correction was desirable for certain purposes, for example the comparison of samples of grain, a considerably less corrected light would give satisfaction for a number of users.

The greater the absorption of the red and yellow portion of the lamp's spectrum, the greater the approximation to cold north light, the less would be the luminous efficiency. A noticeable gain in efficiency could be effected by a reduction of the blue area and the consequent production of a warmer light similar in colour properties to diffused sunlight. It was intended to place alternative types on the market, and he did not think it would be difficult to obtain a general daylight effect, without extreme correction, which would possess a satisfactory efficiency.

It had been hoped to demonstrate at the meeting the first of the stand lamp types of the Sheringham Daylight, but this would be shown with some other types later on. The stand lamp, which would be suitable for general domestic use besides a multitude of commercial applications, would be interesting, because it would use quite a small power lamp compared with the industrial type for use where a large space must be illuminated. A 150 or 200-watt lamp would be used, which would obviate the objection of excessive use of current.

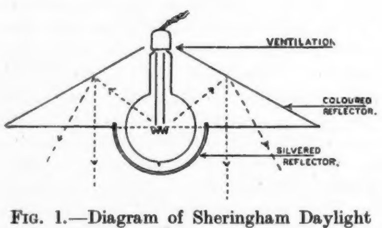


FIG. 1.—Diagram of Sheringham Daylight Lamp.

Mr. Sheringham was making experiments with a new variety of compensator which would constitute a general improver of the lamp rather than a radical transformer. It had been found that if a rather deep conical shade were placed over an ordinary 100 lamp and this shade were coloured on the same lines as the Daylight lamp a considerable change took place in the light from the lamp even without the use of totally indirect lighting. A certain proportion of the light was reflected from the surface of the shade, and that portion was modified to the same extent as it was on the large true Daylight lamp. It was a sufficiently large proportion of the total light issuing from the shade to produce a distinguishable improvement in colours examined under the light, compared with the effect obtained with ordinary shades. This shade would be called a light-improver and must not be confused with the Daylight shade. There was little loss of light

FIG. 2.—Showing method of assembling the latest type of Sheringham Daylight.

and at the same time an excellent white light was obtained which enabled reading to be done without fatigue. Examples would be shown at a later date.

The application of the Sheringham reflector to gas had received consideration, and an apparatus would first be placed on the market which used as the source of light an eight-burner unit. An experimental unit shown a short time ago to the Annual Conference of the Gas Engineers was very favourably commented upon. The spectrum of the incandescent gas mantle being somewhat different to electric lamps, a different arrangement of the coloured areas was necessary.

The scope for artificial daylight widened daily. There were many obscure forms of industry for which a correct colour light was essential. Amongst those interested in this form of lighting he might mention dentists, makers of artificial eyes, telegraphists, grain sampling, diagnosis of skin diseases, bleaching of paper, textile design studios, process block makers, pigment manufacturers, spinners, weavers, carpet manufacturers, laboratories of textile printing works, and textile merchants.

NEON LAMPS FOR LOW VOLTAGE CIRCUITS.

Mr. J. S. Dow (Hon. Asst. Secretary) then showed two samples of a new type of neon lamp, which had been kindly lent for exhibition by the Edison Swan Electric Co., Ltd. In his introductory remarks Mr. Dow recalled that tubes containing rarefied gases had been used as illuminants for a number of years, the Moore tube system of lighting being a familiar example. It was, however, necessary with these systems to have a relatively high voltage, obtained from a transformer connected to an a.c. supply. The length of tube used with the Moore system was considerable, and its chief feature was the low luminosity of the light produced by the electric discharge.

Originally nitrogen was chiefly used. Later the discovery of neon and its subsequent production in commercial quantity enabled the length of tube to be greatly reduced, the intrinsic brilliancy of this gas being higher than in the case of nitrogen, and the light of a vivid orange colour. Lamps utilising only a few feet of tube had been devised and used for spectacular lighting, and he understood that types yielding 400 candlepower, and consuming only 0·5 watts per candle, could be utilised on a 200 v. supply. There was no transformer necessary, and the lamps apparently could be used on direct current. It was, however, necessary to use a special automatic device to start the lamp, and also a steadying series resistance.

The lamps now exhibited represented an entirely new departure as neither starting resistance nor transformer were required. Although the light was not derived from a filament but from luminescent neon gas, enclosed in a bulb, the lamp closely resembled an ordinary small candlepower gas-filled ("half - watt") lamp in appearance. The lamp could be inserted direct into an ordinary lamp socket on a 220 volt supply and the light appeared as an orange glow at the negative electrode.

He understood that the candlepower available with this particular form of neon lamp was at present small, and the efficiency low, but they represented an interesting scientific departure, and would doubtless be further developed in course of time. As it was derived from a gaseous discharge the light was soft and diffused. The lamps exhibited consumed only 5 watts on a 220 volt circuit, and might therefore be useful in cases where only a very small candlepower was needed and economy in current consumption was a primary consideration. He understood that it was possible to make the lamps in such a manner that the glow appeared as luminous letters. A series of lamps could thus be used to form a luminous notice or advertisement. Possibly the special colour of the light, a vivid orange, would lead to other applications. He understood that the lamp was simple in construction and that, as deterioration was only gradual, there was a prospect of a long life.

THE LIGHTING OF RAILWAY TIME-TABLES.

Mr. A. Cunnington, Lighting Engineer to the London and South-Western Railway, briefly described the method of lighting time-tables adopted at Waterloo Station, and recently illustrated in this journal.* The rack had two sloping sides, equipped with glass panels, on which the paper time-tables were pasted. Lamps were mounted at intervals inside the rack, three 20 watt lamps being allotted to each duplicate set of panels (one on each side) so as to illuminate the time-tables evenly by transmitted light. The illumination (equal to about 4 foot-candles) was ample for the figures to be easily read, and the method had the advantage over extraneous systems of lighting that there was no possibility of inconvenient shadows being cast by the bodies of persons reading the time-tables. In addition the striking appearance of the illuminated time-tables readily attracted the attention of passengers.

Mr. Cunnington also briefly described the method of lighting adopted on the escalator at Waterloo Station which, it will be recalled, makes use of large diffusing bowls containing gas-filled lamps.

* Illum. Eng., Oct.-Dec., 1920, p. 270.

A "FOOT-CANDLE METER."

MR. J. S. DOW (Hon. Asst. Secretary) next showed a form of "Foot-candle Meter" which had been lent by the British Thomson Houston Co., Ltd., for exhibition. He recalled that of recent years there had been various attempts made to design photometers on which illumination could be read by inspection without its being necessary to manipulate the parts of the instrument to obtain balance—one case in point being the special instrument devised during the War for testing flares, star shells, etc.*

The instrument exhibited was compact and convenient in form. The light was derived from a small glow lamp fed by a dry cell and regulated by a voltmeter. The photometric scale consisted of a strip of clear glass, over which are pasted two thicknesses of white paper, first a strip of fairly thick paper pierced with circular holes at regular intervals, and over this a strip of thin paper. The lamp was situated underneath the extreme left hand of this scale, and the translucent apertures, covered with fine paper, appeared of progressively diminishing brightness as they receded from the lamp. The unpierced part of the scale was uniformly illuminated by the illumination to be measured, and there would thus be one spot which appeared in balance, while those on either side were respectively brighter and darker. Accordingly the illumination could be read off direct on the scale which was calibrated direct in foot-candles (with a range of 0·05 to 25 ft.c.). The voltmeter scale carries two marks, one designed to give such a current through the lamp that the photometric scale reads directly, the other to give readings to one-tenth of the indicated foot-candles.

Mr. Dow remarked that the instrument had interesting features and was evidently very convenient for rapid work and for purposes of demonstration. But further tests were desirable to ascertain its degree of accuracy as compared with apparatus depending on the usual method of obtaining "balance by adjustment."

* ILLUM. ENG., Nov., 1918, p. 253.

(*DISCUSSION.*)

MR. L. GASTER, in opening the discussion, expressed the Society's indebtedness to those who had been engaged in the presentation of reports and the exhibition of novelties. He was glad to note that, according to the report presented by the Committee on Electric Lamps and Lighting Appliances, the difficulties formerly existing, both in the supply of lamps and of fittings, were being gradually overcome. The introduction of the 40 watt and 60 watt gas-filled lamps was doubtless an important step, if the efficiency claimed could be substantiated, but it was equally important that there should be available an adequate supply of suitable shades and reflectors for use with these lamps. Hitherto the advance in brilliancy had gone ahead of the development of scientific shades and reflectors, and this partly explained why examples of the misuse of gas-filled lamps were still so common. Another explanation was that many of the public still seemed to judge results by the brightness of the filament, instead of by the effective illumination it produced on the place of work. He had experienced this difficulty in factories lighted by gas-filled lamps.

However, the mere provision of sufficient illumination was only a part of the problem, and this had been strongly emphasised in recent industrial codes in the United States. The impression received by the eye depended greatly on

the degree of contrast in brightness. If glare was strikingly in evidence the eye did not get the full benefit of the illumination provided. He was therefore glad to welcome the gas-filled lamps with opal bulbs which Mr. Elliott had exhibited at the meeting, and wished to congratulate the Edison Swan Electric Co., Ltd., on this development. He agreed, however, that in most cases it would be desirable to use a suitable reflector to obtain the best distribution of light, even with lamps of this type. Further, when used at close quarters a shade was still desirable as the brightness, although spread over the opal bulb, would prove trying if near to the eye.

It would be useful to have fuller particulars of the life and efficiency of the 40 watt and 60 watt gas-filled lamps, as compared with lamps of similar consumption of the ordinary vacuum type. In view of the higher cost of replacing gas-filled lamps one would like to feel sure that this was justified by higher efficiency coupled with a sufficiently long period of use before renewal. He also noticed that there were in use lamps closely resembling these small gas-filled lamps in appearance, having filaments of the same type, but, he understood, burning in vacuo. It would be interesting to know how the performance of such lamps compared with the small gas-filled lamps. If their life and efficiency were inferior this should be recognised, as the public was apt to regard the two kinds of lamps as the same.

The neon lamps, publicly exhibited, he believed, for the first time in this country, represented an interesting departure. He understood that such lamps were easy to make, and were likely to have a long life. While the efficiency at present was apparently low, it was quite possible that there might be substantial improvements in this respect in the future, and it appeared that their special properties, notably the orange colour of the light and the low consumption attainable on 200 volt circuits, might enable them to prove very useful for various special purposes, such as advertisement signs, and possibly luminous signals, for aircraft.

In regard to the report of the committee on Progress in Gas Lamps and Lighting Appliances, he wished to thank Mr. Bridger and the other members of this newly constituted committee for their help, and he hoped that the annual reports of this committee would prove a permanent feature of value, both to the Society and to the gas industry. In regard to one point raised in this report, namely, the importation of glassware and mantles, while they would naturally share the view that the gas lighting industry should not be hampered in its development, it might be felt that this raised somewhat wide issues. It was possible that a different view might be taken by other sections of the industry. The Society, while anxious in every way to encourage progress in lighting, had to exercise caution in view of the possibility of industrial and manufacturing problems becoming involved in political questions, of which it must be kept independent.

The new form of photometer shown by Mr. Dow was also an interesting development. As a portable instrument for purposes of demonstration it appeared to have advantages, especially in explaining to consumers the benefits of alterations in lighting arrangements. At the present time much interest was being taken in instruments for measuring illumination. Quite a number had been shown at meetings of the Society, and there was doubtless room for a variety of different types. The matter was of special interest in view of the prospective introduction of requirements of adequate lighting in factories and workshops, compliance with which naturally involved suitable measuring instruments being available.

Finally, he wished to congratulate Mr. Sheringham and his colleagues on the

further development of his artificial daylight apparatus, and they looked forward with interest to the introduction of the portable types referred to by Major Klein in his address. It was evident that substantial progress had already been made, and there was no doubt that a promising field for the use of suitable apparatus of this kind existed in many industries.

Mr. J. C. ELVY emphasised the importance of accurate figures in regard to the performances of gas-filled lamps, and the desirability of lower prices. It appeared that the efficiency of the 40 watt and 60 watt types of gas-filled lamps was not materially different from that of the corresponding vacuum type lamps; unless the price was diminished, there was not much inducement to consumers to use the gas-filled lamps of these types.

In particular, one should feel sure that such lamps actually consumed the assigned wattage. What guarantee had one that a 60 watt lamp actually consumed 60 watts? If such a lamp proved to take 70 watts a consumer would not be satisfied even if the output in lumens was correspondingly increased. In a case recently brought to his notice 100 watt lamps were installed, and it was found that the bill for electricity had increased beyond the estimated amount. Ultimately it was found that certain of the lamps used were taking 150 watts.

He had also noticed an apparent discrepancy between the figures given by lamp-makers and those assigned by a firm of manufacturers of reflectors, the candlepower being 15—20 per cent. lower in the latter case. It was clearly desirable to have uniformity of practice in presenting such figures.

Mr. J. W. ELLIOTT, in replying to Mr. Elvy's remarks, said that the same guarantee was available in regard to gas-filled lamps as for any other type. Measurements could be made at the National Physical Laboratory, and users, consumers or contractors could have access to the lamp-makers' works where their measurements could be checked. His company, as lamp-makers, could produce N.P.L. certificates for each of their standards, and he thought every manufacturer of repute would have such tests made by the N.P.L. The best selling point in regard to any lamp of marked wattage was the production of their certificate.

As Mr. Gaster had often pointed out, consumers should obtain a guarantee with their lamps. With up-to-date methods of manufacture it was easy to give the wattage required; in fact, with drawn wire filament lamps this could be done more readily than was the case when only carbon filament lamps were manufactured.

It was difficult to say when the prices of electric lamps, in common with the price of other commodities, would come down. But as soon as conditions became normal it was hoped that a reduction would be made, and they might also look forward to the introduction of gas-filled lamps of even lower consumption than the 40 watt and 60 watt sizes.

In regard to the efficiency of the gas-filled lamp, it must be remembered that when the term "Half-Watt" was originally used only very large units were available. As a matter of fact, the efficiency of some such lamps was even better than the "half-watt," as with the 1,000 and 1,500 watt sizes were being manufactured at 0·4—0·5 watts per candle. The smaller sizes, while naturally not so efficient as the high candlepower types, were more efficient than the vacuum type. Thus, the 40 watt gas-filled lamp was 30 per cent. better in efficiency, and considering the concentration of the light and improved colour-value, one had the advantages looked for in such a lamp for domestic use. The lamps with opal bulbs, shown by Mr. Staines, were particularly well adapted to shop-window lighting, as the filament was completely obscured and glare avoided.

Mr. J. S. DOW thought that it would be interesting if Major Klein or Mr. Sheringham would tell them a little more about the special problems met with in applying the Sheringham daylight to colour-matching. Mr. Sheringham had mentioned one interesting case that had recently arisen, namely, in judging the colour of precious stones.

Major KLEIN said in regard to judging precious stones the difficulty was that the image formed on the facet of the stone showed the individual colours of the pattern. A complete picture of the lamp was shown on the surface of the stone. To avoid that it was proposed to place between the reflector and the stone a frame over which tracing paper was stretched. By that means they got a white light. However, the reduction in brilliancy by the diffusing transparent tissue paper was so great that there was an insufficient amount of light on the stone for practical purposes. They now proposed to use a weak condensing lens, and cast on the stone a circular image out of focus, which would likewise serve to diffuse the rays coming from the reflector to get a good concentration of light on the stone without any image on the reflector. Any reduction of brilliancy in the ideal purity of the original powder-colours had a considerable effect. It was essential to keep a blue which was the equivalent of the pure blue powder. If varnish or oil were mixed with the powder there was an enormous change in the brilliancy, and when water colour was used and the colour was wetted, the surface was actually transparent, the white paper through the blue light went all blue, and one got an almost ideal brilliancy. A surface was required that could be washed, and possibly even rubbed, and this necessitated a medium which would bind the particles of the pigment strongly. This medium bound them as strongly as a light oil or varnish, and yet left the surface matt.

Mr. R. E. THRELFALL, of Messrs. Chance Bros. and Co., said he had hoped that Mr. Lamplough, their Director of Research, would have been there to give their experience of the production of "artificial daylight." It appeared that one might perhaps make a colour-correcting glass to surround the half-watt lamp in the form of a bulb or envelope. If this were made with glass pure enough it would convert the light of the half-watt lamp into a close resemblance to daylight. He had been interested in blue and green glass sent over from Germany which was claimed to do that, but which did not do it. It could not be done unless the glass were of very good optical quality. They were interested in getting a glass by which colours could be matched, as in the dyeing trade. At the Efficiency Exhibition in February, if they were so fortunate as to be able to make the glass required, they hoped to exhibit this glass, and members would have the opportunity of seeing it there.

Mr. GASTER expressed the hope that they would have an opportunity of seeing it at the Society's meeting first.

On the motion of the CHAIRMAN a cordial vote of thanks was moved to those responsible for the presentation of reports and exhibits of apparatus. The Chairman also announced that Mr. J. HERBERT PARSONS, K.C.B., F.R.C.S., had been elected PRESIDENT of the Society. He hoped that they would have the pleasure of welcoming him at the **next meeting** on **January 18th,** when a discussion on "**The Use and Abuse of Light in Studios for Cinema Film Production**" would be opened by Mr. J. C. ELVY.

ROYAL SANITARY INSTITUTE.

Thirty-second Congress and Exhibition.

We are informed that the Thirty-second Annual Congress and Exhibition of the Royal Sanitary Institute will take place at Folkestone during June 20th—25th, 1921. An inaugural address will be delivered by the President of the Congress (The Rt. Hon. the Earl of Radnor). A series of papers and discussions has been arranged, divided into five sections, comprising: (A) Sanitary Science and Preventive Medicine; (B) Engineering and Architecture; (C) Hygiene of Maternity and Child Welfare; (D) Personal and Domestic Hygiene, and (E) Industrial Hygiene.

Particulars may be obtained from the Secretary of the Royal Sanitary Institute, 90, Buckingham Palace Road, London, S.W.1.

THE CURRENT-DENSITY IN THE CRATER OF THE CARBON ARC.*

By N. A. ALLEN, B.Sc.

SOME highly interesting experiments, undertaken at the East London College at the suggestion of Professor J. T. MacGregor-Morris, were described in the paper on the above subject recently read by Mr. N. A. Allen before the Physical Society. The author first summarised the results of Mrs. Ayrton and other observers, pointing out various sources of difficulty in measuring the crater-area, which, however, disappear if a "Y-shaped" arrangement of carbon (originally used by Forrest) is adopted, *i.e.*, two inclined negatives pointing to the positive, and leaving between their terminal points a clear space through which an enlarged image of the positive crater can be thrown on a suitable screen. In these circumstances it can be seen that the positive crater covers the whole of the end of the carbon for all currents exceeding 0·2 amps per sq. mm. A diagram is presented by the author tracing the changes in the crater which occur with increasing currents. When the arc has burned into a steady condition the carbon in all cases tapers down uniformly at an angle of about 25°. The crater is at first quite flat and smooth, and perpendicular to the axis of the carbon, but when the current increases to a point where the arc becomes unsteady and hisses, then the crater-area becomes broken and indented.

Reviewing various possible sources of error the author comes to the conclusion that the accuracy of measurements falls within 1 per cent.

The most interesting result found in these researches, however, is the new relation established between the crater area and current in amperes. Previous observers have invariably found that this relation is linear, but that the straight line crossed the X-axis of co-ordinates (representing crater area) some distance above the origin. In other words the relation was of the general form for a straight line, viz., $y=mx+c$. Mr. Allen, however, finds that, as a result of the precautions taken, this inclined line *passes direct through the origin*. In other words, the equation assumes the simple form $y=mx$. Hence the *crater area is directly proportional to the current and the current-density is constant*. This is further illustrated by means of a diagram connecting current density and actual current, which yields a straight horizontal line graph, corresponding with a constant current density of 0·745 amps. per sq. mm. As it has previously been shown by Forrest that the brightness of the crater remains substantially constant at 173 candles per sq. mm., it was pointed out by Professor J. T. MacGregor-Morris in the discussion that a new relation for the arc may be deduced—namely, that the candlepower of the arc is given by 173/0·745, *i.e.*, 232 candles per ampere. It would appear, therefore, that by taking the necessary precautions the candle-power of such an arc may be at once deduced if the current is accurately measured. This offers up a possible basis of an arc standard of light, and we understand that this matter is receiving further investigation.

*** Abstract of a paper read before the Physical Society.**

TOPICAL AND INDUSTRIAL SECTION.

[At the request of many of our readers we have extended the space devoted to this Section, and are open to receive for publication particulars of interesting installations, new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona-fide* information relating thereto.]

BLAND NEW VITREOSIL BURNERS.

An interesting departure has been made by the Bland Light Syndicate, Ltd., in connection with incandescent gas burners, namely, the use of special "Vitreosil" small protectors, composed not of glass but of silica, fused electrically at a high temperature. These small "intensifiers," it is stated, are able to withstand not only great heat, but very marked changes in temperature without breaking, and they can accordingly be brought very close to the mantle. Fig. 1 shows the general appearance of the intensifier equipped with bayonet carrier.

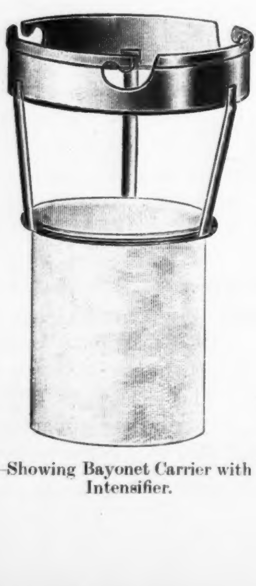


Fig. 1.—Showing Bayonet Carrier with Vitreosil Intensifier.

Fig. 2.—$1\frac{7}{8}$ in. fitting (100 c.p.) Burner complete with intermediate size mantle and Vitreosil Intensive Globe.

The material of the intensifier is opalescent, and this is useful in diffusing the light and giving a softer and more restful effect. Another important advantage of this close juxtaposition of the vitreosil protector to the mantle is the intensification of the flame temperature of the gas at the ignition point, which is conveyed to the fabric of the mantle and leads to materially improved efficiency. We understand, for example, that a bijou

burner with a 1⅞ in. gallery can be fitted with a small medium mantle consuming only 1·75 cubic feet per hour, and that with the Vitreosil Intensifier this gives a duty of 100 candles. Similarly a medium-sized burner, 2¾ in. fitting, fitted with a Universal size mantle, is stated to yield 150 candles, roughly 43 candles per cubic foot of gas consumed per hour—certainly a remarkable result with low pressure gas.

The burners to which this new device are attached are of a new type with "Venturian Tube Bunsens," and are specially constructed to suit any quality of gas, an important item in view of the lower grades of gas that are now being introduced. Another feature in the design of the burners is the care taken to avoid any conditions liable to cause noise during burning—a completely silent burner being, in some circumstances, a desirable condition that demands very careful design. A typical burner is shown in Fig. 2.

THE ROYAL EDISWAN "FULLOLITE" LAMPS.

One of the principal objections to the use of the ordinary type of gas-filled lamp for shop window lighting, etc., where lamps are often used without shades, and are set at an eye level, has been the glare effect of the intensely brilliant filament. A similar objection is also met with in office and domestic lighting when methods other than the indirect system are employed.

The "Fullolite" lamp, which has recently been introduced by the Edison Swan Electric Company, Ltd., is designed to meet this objection. It consists of the usual gas-filled lamp, but the bulb is of opal glass instead of the usual clear glass. The opal bulb is stated to eliminate completely the glare of the filament, excellent diffusion of light being obtained.

The surface of the opal glass being smooth and polished, the bulb does not collect dust in the same way that the ordinary sandblasted or acid-obscured lamp, with its roughened surface, is apt to do. The new lamps can be obtained in all standard voltages and ratings up to 200 watts.

THE GROWTH OF THE MINIATURE LAMP BUSINESS IN THE UNITED STATES.

According to the *Electrical World* the sales of miniature lamps in the United States have tripled since 1912, and are still expanding very rapidly. It is estimated that during 1920 the figure of 125 millions has been reached, distributed as follows:—

Automobiles ..	77,000,000
Flashlights	36,000,000
Christmas Trees ..	9,000,000
Miscellaneous	3,000,000
	125,000,000

Thus lamps for automobiles and flashlight torches account for 90 per cent. of the demand. "Miscellaneous" includes electric toys, lamps used with special instruments by doctors, dentists, etc. There are at present about 150,000 portable electric miners' lamps in use, and as the U.S.A. Bureau of Mines approves such lamps their more general introduction is anticipated. Another feature is the increasing use of small motion-picture outfits in schools.

CHANGE OF ADDRESS.

Messrs. Wallis-Jones & Dent, Consulting Engineers (Mr. Reginald J. Wallis-Jones, M.Inst.C.E., M.I.E.E.), have removed to their new office at "Adams House," 23, Old Queen Street, Westminster, London, S.W. 1. Telephone: Vic. 8070. Telegrams: "Alteration," Vic., London.

COLOUR-MATCHING FITTINGS.

It will be recalled that some time ago reference was made to a form of colour-matching fitting supplied by the Engineering & Lighting Equipment Co., Ltd., of St. Albans. A view of this fitting is seen in the accompanying illustration. The unit consists of a deep shade covering a gas-filled ("half watt") lamp and having under the lamp a series of three special glass screens, tinted in such a way that the transmitted light approaches very closely to daylight in colour. The nature of these screens has been determined by careful comparison between the appearance of coloured objects as revealed by the light, and by daylight, and it is stated that the lighting unit has been used to a considerable extent by paint works, calico printers, dye works, etc., where accurate colour-matching is involved. More recently it has also been used in a number of large stores in order to enable ribbons and coloured goods to be examined.

The use of the three screens in order to produce the desired resemblance to daylight naturally involves a considerable reduction of light and accordingly it is not recommended that the lighting units should be used for general illumination; they can, however, be conveniently used to illuminate a relatively small area, set apart for colour-matching purposes.

General View of Colour-Matching Unit.

UP-TO-DATE LIGHTING IN A LARGE STORE.

We have received from the General Electric Co., Ltd., some particulars of the lighting of the premises of Messrs. W. Parnell and Co. (Wilton Road, Victoria), illustrated by photographs showing their show-windows and a part of the interior.

Fig. 1 shows the method of lighting adopted in the showrooms, which are illuminated by semi-indirect fittings, equipped with bowls of "Verilux" ("Celestialite") glassware and gas-filled lamps furnished by the General Electric Co., Ltd., whose lighting experts co-operated in the design of the entire scheme. This glassware is considered specially suitable for the lighting of drapers' stores, as it is designed to transmit light closely resembling daylight in colour. It is composed of three layers, firstly a body of clear glass, secondly a light-diffusing coating, and thirdly a layer of bluish glass, which is intended to filter out the excess of red and yellow and yield a soft white light, suitable for the display of coloured goods.

Fig. 2 shows the appearance of a typical window, the photograph being taken entirely by the light of the concealed window-fittings. The lighting is effected by 100 watt gas-filled lamps in trough-reflectors, mounted just inside the window on the ceiling so as to be well out of the normal line of vision. The lamps are wired on two circuits, so that the amount of light can be varied according to the nature of the display.

THE BENEFITS OF GOOD INDUSTRIAL LIGHTING.

A series of attractive leaflets, emphasising the benefits of good industrial lighting in the interests of health, safety and efficiency, have been issued by the Benjamin Electric Ltd. We notice particularly the stress laid upon the value of adequate lighting as a means of eliminating accidents—"the Fear that Fetters Production." Poor factory illumination is described as "the Industrial World's Greatest Criminal," who injures workmen, steals time and spoils costly material.

Fig. 1.—A view of the Showrooms, lighted by gas-filled Osram lamps in bowls of Verilux ("Celestialite") glassware.

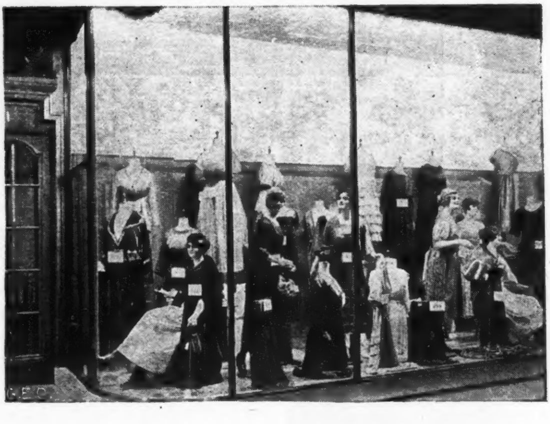


Fig. 2.—A typical window lighted by 100-watt gas-filled Osram lamps in special trough reflectors mounted along the top edge of the window.

THE LIGHTING OF A LARGE STORE.

(Messrs. Parnell and Co.'s premises in Wilton Road, Victoria, London, S.W. 1.)

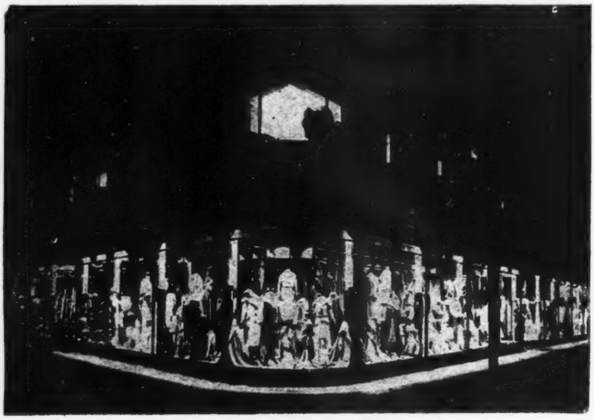
SHOP-WINDOW LIGHTING.

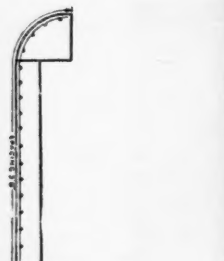
It is now accepted as a fundamental principle that in shop-window lighting the sources of light should be invisible, and the observer should see only the illuminated goods. A second maxim is that the light should be efficiently concentrated on the display, none being wasted on the pavement or directed into the eyes of prospective customers.

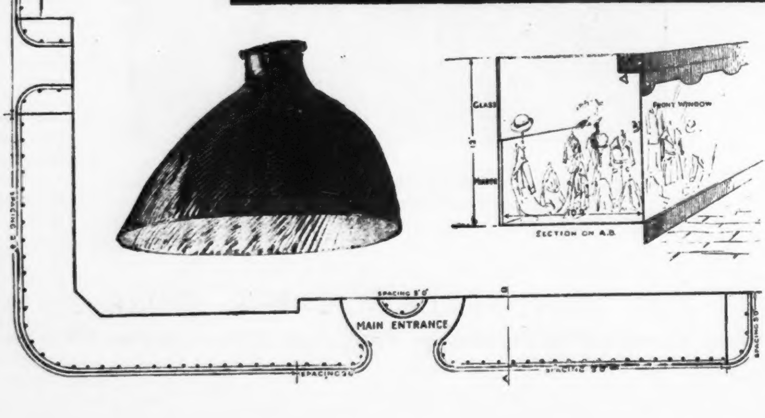
An example of effective window lighting is provided by the recently completed installation at Messrs. Bunting Ltd., of Norwich, particulars of which have been furnished by the British Thomson Houston Co. Ltd. The equipment consists of "X-Ray" mirror glass reflectors and Mazda gas-filled lamps supplied by the above firm. The units are fixed along the top front edge of the window. A feature is the special shaping of the reflectors so as to concentrate the lights on the goods. In this case the upper half of the background was composed of clear glass, and it was considered advisable to prevent any direct light from the X-Ray units being projected into the interior of the shop. The units employed were specially selected for this purpose, the distance apart of the reflectors being 2 ft. in the deepest windows and 3 ft. in the shallowest. A narrow outline of decorative appearance is fixed between the reflectors and the window in order to conceal the reflectors from the view of people in the street. In all 83 reflectors and a similar number of 100 watt gas-filled lamps are used.

The second illustration gives a good idea of the effect produced which is substantially similar to that of the stage of the theatre, attention being naturally drawn to the brightly lighted contents of the window, in contrast with the surrounding darkness.

Plan of Lighting Arrangements and View of Windows of Messrs. Bunting Ltd. (Norwich).







INDEX, January, 1921.

A JOURNALISTIC AMALGAMATION.

We understand that *Ways and Means* and *Common Sense* are now amalgamated. The former was started by Mr. F. W. Hirst after relinquishing the editorship of *The Economist* four years ago, while the latter was the outcome of the work of Mr. Ernest Benn. The policies of the two papers have much in common, and it is hoped that their union will add to their influence in stimulating progressive industrial thought.

"THE TRANSPORT WORLD."

Benn Brothers, Ltd., are publishing *The Transport World : The Journal of the Road Carrying Industry*, a new weekly for all interested in motor road transport. A freight exchange section will provide each week an immediate index of freight ready for delivery, and offers of transport in vehicles running to and from all parts of the country. It is hoped that the regular use of these columns by producers and carriers will remove the chief hindrance to trade expansion by utilising the enormous "Return Empty" mileage which is now lost. The issue of this new journal illustrates the tendency towards specialisation in technical matters and its progress will be watched with interest.

REVIEW OF BOOK.

The Electrical Engineer's Diary, 1921. (*S. Davis and Co., London, pp.* 582. 10*s.* 6*d.*).

We are glad to welcome the thirteenth annual issue of this diary, which we note contains 100 pages of added matter. Indeed, a feature of the diary has been the steady growth in the amount of information afforded. The 48 pages of the 1908 edition have been increased approximately twelve times ; the price, however, has not risen proportionately, being 10s. 6d. as compared with 2s. 6d. for the first issue.

In the present edition new matter has been included to many sections, notably those dealing with cables, heating, cooking and cleaning ; and a new section has been added dealing with electrical vehicles and electric trucks. We notice, also, various additions to the lighting section, comprising charts for calculations of industrial lighting, data on indirect units, and comparisons of horizontal and vertical illumination.

The standard items, such as the data on supply stations, accompanied by lists of streets covered by companies in the metropolitan area, are again presented, and we have no doubt that the 1921 edition will be found even more useful than its predecessors.

HOLOPHANE ADJUSTABLE CANOPY.

We have received particulars of a new adjustable canopy which enables the filament of a gas-filled lamp to be readily adjusted to the correct position within the reflector, thus ensuring that the desired distribution of light is preserved.

A diagram of the canopy is shown in Fig. 1, and a view of a complete unit equipped with it in Fig. 2. The canopy is seen as a brass spinning of inverted bell shape flared outward towards the top where it is fitted with a cast brass three-armed spider. The spider screws up and down on a centre rod carrying the suspension hook and lamp-holder. A set-screw or locknut locks the canopy to the rod in the desired position. The arms of the spider are slotted, each slot carrying a roller over which passes the chain supporting the gallery of the reflector. Immediately above the lamp-holder is a washer, seated sufficiently closely to permit free turning. The inner ends of chain are secured to this washer, the chains then passing over the rollers in the spider (through slots in the well of the canopy) and engaging at the other ends of the gallery which holds the reflector.

The gallery is reversible and can accommodate reflectors with neck of either 3¼ or 4 ins. diameter. When the set-screw is slackened the whole fitting may be rotated and the canopy screwed up and down the rod; the canopy in rising carries with it the reflector, but the lamp-holder and lamp remain stationary during all adjustments. The reflector executes a movement twice as great as that of the canopy, *i.e.*, the maximum amount of adjustment possible is double the screw-threaded length of rod. The adjustment of the reflector has no effect on the flexible cord and no provision need be made for taking up slack.

It is proposed to issue with each canopy a label giving particulars of standard positions for various Holophane reflectors, and a measure in inches to aid the user in making adjustments.

We are informed that the adjustable canopy is the invention of Capt. E. Stroud and that the exclusive rights have been obtained by Holophane Ltd., from whom the canopy will be available very shortly.

Fig. 1.—Showing pendant fitting equipped with Holophane Adjustable Canopy.

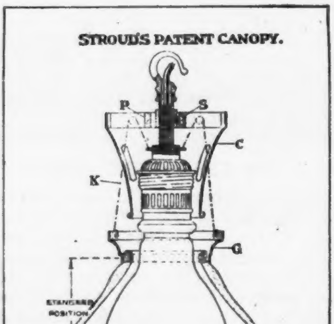


Fig. 2.—Showing details of Holophane Adjustable Canopy.

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The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by LEON GASTER

THE JOURNAL OF SCIENTIFIC ILLUMINATION.

OFFICIAL ORGAN OF THE

Illuminating Engineering Society.

(Founded in London, 1909.)

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32, VICTORIA STREET, LONDON, S.W.1.

Tel. No. Victoria 5215.

EDITORIAL.

The Use and Abuse of Light in Studios for Kinema Film Production.

The discussion on this subject before the Illuminating Engineering Society on January 18th formed a useful supplement to its other researches in the field of kinematography. It will be recalled that a report on "Eye-strain in Kinema Theatres" was presented to the L.C.C. by the Joint Committee appointed by the Society last year, and that at the Annual Meeting in May, 1920, a discussion on "Types of Portable Kinema Projectors" was opened by Captain J. W. Barber. In both these sections of kinema work problems of great interest to illuminating engineers were raised, and the discussion on "Studio Lighting" showed that here again there are opportunities for useful work by the lighting expert in co-operation with managers of film studios, kinema photographers and others concerned.

The subject was a timely one for discussion in view of the reports of alleged injury to the eyesight of actors attributed to the effect of very powerful lights used at close quarters in some studios. The matter has been referred to the committee of the Ministry of Health dealing with the causes and prevention of blindness.

The discussion was fully representative of the views of producers of films, photographic experts and makers of lamps for use in studios, while Mr. A. Lugg, General Secretary of the Actors' Association, stated the case on behalf of artists engaged in film work. A number of interesting points emerged from the discussion. The view was expressed that such cases of eye-trouble as occur are occasionally due to artists looking direct at the powerful lights, and it was suggested that an express warning against this practice should always be given. Further, as some eyes may be more easily affected by exposure to bright lights than others, it has been suggested that the eyes of actors should be tested before they are asked to undertake work under very strong artificial light. The view was expressed, however, that it is scarcely ever necessary for powerful unscreened lamps to be employed at close quarters in order to obtain a successful film. Some speakers indeed contended that, apart from any question of effect on eyesight, the use of screened lights and methods of diffusion, approaching more nearly to natural lighting, is desirable on artistic grounds. When the source constitutes a point of light shadows are apt to be harsh, and unduly great contrasts of black and white are produced. Finally it has been pointed out that the amount of money expended on lighting a scene forms only a very small proportion of the total costs of production and that, therefore, it is well worth while to spend a little more, if necessary, on the expenditure of energy for lighting, if by suitable methods of screening, etc., a better film can be secured and at the same time due precautions taken against any probable prejudicial effect on eyesight.

Another point of great interest, apart from the brightness of the sources of light used, is the quality of the radiation. The colour of the light yielded by the illuminants commonly used in studio-lighting varies considerably. In particular, some sources are richer in the ultra-violet light (the rays immediately beyond the visible violet in the spectrum) than others. Some experts appear to regard the accentuation of the ultra-violet as desirable from the photographic standpoint, while others suggest that they are of relatively small value in this respect, and that these rays are, to a great extent, absorbed by the camera lens. On the other hand, some authorities consider that exposure of the eye and skin to excessive amounts of these rays has a prejudicial effect. There are thus quite a variety of facts to be considered in connection with the effect of light on the eye in kinema studios, as well as the methods of lighting conducive to the production of successful films.

The Illuminating Engineering Society is accordingly forming a Joint Committee to consider these problems, on which the co-operation of representatives of the kinema industry, photographic experts, ophthalmic surgeons and others concerned has been invited. Whereas the Committee sitting under the Ministry of Health is concerned with one particular problem of studio-lighting, namely, the possible ill-effects of injudiciously used illuminants on eyesight, the proposed Joint Committee appointed by the Illuminating Engineering Society, as indicated above, will have to survey the whole field of studio-lighting in its varied aspects, and should serve as a permanent source of information on this subject. Through its representative and technical constitution it will bring into co-operation the services of experts hitherto working independently on individual lines and will be in a position to deal with the problem in an impartial and authoritative manner.

Some Suggested Lines of Investigation on Kinema Studio Lighting.

As an indication of the scope of the inquiry to be undertaken by such a Committee we should like to summarise a few problems that deserve study.

Effects of Light on Eyesight.

Independent of Mr. Elvy's paper, a list of queries on this subject has been drawn up by the Society and is reproduced on the following page (page 30). A number of replies to this inquiry have already been received, and we should welcome further data from kinema producers and actors, ophthalmic surgeons and others interested.

The Nature of Light Yielded by Different Studio Lamps.

In view of the importance of quality of radiation from studio lamps, both in regard to possible influence on eyesight and photographic value, it would be useful to have full data showing the distribution of energy in the spectra of these various illuminants. We are accordingly collecting the existing data for reference purposes.

Sensitiveness of Film Throughout the Spectrum.

The utility of light from various parts of the spectrum is naturally dependent on the distribution of sensitiveness of the film used. This should accordingly be studied in conjunction with the above problem.

Comparative Luminous and Photographic Efficiencies.

While occasional tests, somewhat difficult to interpret, have been made with various illuminants, and conflicting statements are frequently made, no adequate comprehensive series of experiments of an authoritative character on the comparative photographic and luminous efficiencies of the various studio lamps appears to have yet been made in this country. It would be most helpful to have such tests made.

Intensity of Illumination Required in Studios.

Little information is available on the illumination necessary to secure a successful film with different types of subjects, although such data are a familiar asset in other fields of illuminating engineering. There should be no great difficulty in obtaining such data, which would be helpful in fixing the exposure, assuming that the relative photographic effect of the illuminant for a given illumination has also been determined.

Effect of Shading and Diffusing Light.

Experiments in studios lighted by naked lamps and lamps equipped with diffusing screens or other methods of softening shadow and diminishing glare might be undertaken, with due regard to the quality of results obtained in each case, the degree of absorption of light, and the increase in expenditure of energy (if any) necessitated by such methods of shading.

General Recommendations on Studio-Lighting.

The above list of investigations is naturally intended as suggestive merely, and might be modified or extended. As a result of such inquiries it should be possible to prepare some simple recommendations on the lighting of studios, relating to such points as the minimum distance of unshaded lights from actors, the degree of illumination necessary, and the best methods of diffusing light, which would be of considerable value, both to the kinema industry and the general public.—L. GASTER.

TENTATIVE LIST OF QUERIES ON THE USE AND ABUSE OF LIGHT IN STUDIOS FOR KINEMA FILM PRODUCTION.

The Illuminating Engineering Society.

(Founded in London, 1909.)

Managers of kinema studios, actors, ophthalmic surgeons and others interested are invited to submit information on the following list of queries, which has been prepared by the Illuminating Engineering Society. Replies should be addressed to the Hon. Secretary (L. Gaster, 32, Victoria Street, London, S.W.1).

(1) Are you aware of any cases of injury to eyes of actors in kinema studios which are attributable to special lighting conditions?

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(2) If so, was the injury (A) temporary or (B) permanent? If temporary, how long did the prejudicial effects continue? Is the effect experienced immediately after exposure or is it gradual and progressive?

---

(3) Is such injury, in your opinion, occasioned by:—

(A) Exposure to very brilliant sources of light of high candlepower? or

(B) The presence of a high proportion of ultra-violet light in the illuminant used, such as may be considered desirable from the photographic standpoint? or *both?*

---

(4) Is it, in your opinion, absolutely necessary for the successful preparation of films that powerful unscreened illuminants should be used? Or do you agree that satisfactory results can be obtained by using illuminants with a light-diffusing screen in front, thus minimising glare? In this case would it be desirable to determine the minimum brightness (candlepower per sq. in. of the illuminant, either unscreened or shaded) which can be considered safe in regard to effect on eyesight?

---

(5) In view of the fact that certain eyes are more susceptible to the effect of powerful light than others, and that this susceptibility may be increased by impaired health, do you consider it desirable that artists should have an opportunity of inspecting the lighting arrangements before undertaking work? And that their eyes should be tested before work is undertaken in order to detect any source of weakness such as might unfit them for taking part in kinema acting involving exposure to very powerful lights?

---

(6) Are there any precautions (such as the wearing of glass goggles in the preliminary stages before the scene is actually filmed) which you would suggest as desirable in kinema studios?

TRANSACTIONS

OF

The Illuminating Engineering Society

(Founded in London, 1909.)

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

THE USE AND ABUSE OF LIGHT IN STUDIOS FOR KINEMA FILM PRODUCTION.

(Proceedings at a meeting of the Society held at the House of the Royal Society of Arts, 18, John Street, Adelphi, W.C., at 8 p.m., on Tuesday, January 18th, 1921.)

A MEETING of the Society was held at the House of the Royal Society of Arts, London, at 8 p.m. on Tuesday, January 18th, the chair being taken by the PRESIDENT (Mr. J. Herbert Parsons).

The Minutes of the last meeting having been taken as read, the HON. SECRETARY read out the following names of new applicants for membership :—

Collings, J. F.	Inspector, Public Lighting Dept., South Metropolitan Gas Co., 17, Handen Road, Lee, S.E.
House, L. P.	Electrical Engineer, "Glencoe," Warwick Road, Cliftonville, Margate.
French, J.	War Office Searchlight Experimental Dept., 17, Thorpewood Avenue, Sydenham, S.E.
White, E. S.	War Office Searchlight Experimental Dept., 58, Moresby Road, Clapton, S.E.
Wolf, E. M.	Electrical Dept., Messrs. Bovis Ltd., Upper Berkeley Street, London, W.1.

The HON. SECRETARY also read again the names of applicants for membership announced at the previous meeting,* and these gentlemen were formally declared members of the Society.

Mr. J. HERBERT PARSONS, in opening the proceedings, briefly expressed his pleasure in accepting the Presidency of the Society. The PRESIDENT then called upon Mr. J. C. Elvy to open the discussion on **"The Use and Abuse of Light in Studios for Kinema Film Production."** An interesting discussion ensued in which the following took part :—Mr. W. DAY, Mr. A. G. WAY (Westminster Eng. Co., Ltd.), Mr. F. J. HAWKINS (Hewittic Electric Co., Ltd.), Mr. PULLVER (Duncan Watson and Co.), Mr. H. A. CARTER (G.E.C.), the Rt. Hon. G. H. ROBERTS, M.P. (Chairman of the Ministry of Health Committee on the Causes of Blindness), Mr. ALFRED LUGG (Gen. Secretary of the Actors' Association), Capt. J. W. BARBER, Capt. P. KIMBERLEY (Hepworth Picture Plays, Ltd.), Mr. COLIN BENNETT, Mr. H. M. LOMAS, Mr. S. ROWSON (Ideal Film Co., Ltd.), Mr. P. KING, Mr. T. W. ARMES, and Mr. L. GASTER.

After a vote of thanks to the speakers and exhibitors the PRESIDENT announced that the **next meeting** would be held on **February 24th,** when there would be a discussion on **"Light as an Aid to Publicity"** (show window-lighting, illuminated signs, etc.).

* ILLUM. ENG., Jan. 1921, p. 5.

ARTIFICIAL ILLUMINATION FOR KINEMATOGRAPHY:

The Use and Abuse of Light in Studios for Kinema Film Production.

By J. C. ELVY, A.M.I.E.E

Introduction to a discussion at the meeting of the Society held at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C., at 8 p.m., on Tuesday, January 18th, 1921.

Introduction.

Before dealing with the technical side of present-day practice I propose to put before you some information I have gleaned on the origin of the kinematograph film as we know it to-day and which tends to prove this country as its place of origin.

For fuller details of these historical aspects readers may be referred to the researches of Mr. Will Day, who has collected together at his Lisle Street premises several very interesting exhibits, some of which he has kindly promised to show us this evening. I may also refer, among other publications, to the book by Mr. R. B. Foster, B.Sc., published in 1915.

According to this authority, *Persistency of Vision* was probably observed in prehistoric times by rotation of a burning ember. Further, about **65** B.C. it is mentioned by Lucretius; A.D. **130** by Ptolemy; A.D. **1100** by Alhazen, and subsequently by Newton and Boyle. Little was done, however, until Segner, D'Arcy and Cavallo attempted to measure length of duration of vision after extinction of light and with various colours.

1825. Dr. Roget's Memoirs regarding moving objects in the *Philosophical Review* mention apparent distortion of a rotating wheel when viewed through the slots of a vertical fence.

1830. Dr. Plateau of Ghent invented the Phenakisticope, a revolving disc to portray life movement.

1832. Dr. Plateau sent Phenakisticope to Dr. Faraday.

1830-1832. Dr. Stampfner of Vienna invented a similar instrument to Dr. Plateau's.

1836. Dr. Plateau invented the Anorthoscope.

Subsequently Dr. Faraday demonstrated the action mentioned by Dr. Roget by what became known as "Faraday's Wheel," consisting of two radially notched wheels, rotating about the same axis, side by side, but in opposite directions.

1850. Dr. Tyndall demonstrated the motion of water jets by the electric spark.

1851. Dr. Fox Talbot suggested instantaneous photography by the same means.

All sorts of novelties were being invented during this period. Some of us can recall such toys as the Thaumatrope, an example being the card, with a bird printed on one side and a cage on the other, the card being spun round by aid of strings, with the result that the bird appears in the cage.

Packs of cards later developed into "Penny-in-the-Slot" machines, such as Messrs. Lumière's "Kinora."

The difficulty had already been experienced of the inability to secure impressions of images on photographic plates in a sufficiently short time.

1860. Dr. Desvignes obtained series of views of steam engine in action. Obviously, the process involved was simple, every moving part following a predetermined path. With living creatures this was impossible at that time.

1866. Dr Beales invented and patented the Choreutoscope—a magic lantern slide with a series of pictures.

1870. Dr. W. B. Carpenter described the Zoetrope at the Royal Society, of which he was vice-president at the time.

1877. Dr. Muybridge erected a line of cameras, the lenses of which were operated by electromagnetic devices, which were in turn operated by contact being made with the feet of the horse treading on the several electric wires whilst trotting along the frontage. A light coloured background was provided, and a series of instantaneous pictures was thus secured.

1881. Lommel suggested a beam of light and interrupter-device, such that

several people could view such images simultaneously.

***1888.** Introduction of celluloid, which made the kinematograph film possible.

***1889.** Dr. Friese Green produced the first film portraying animated photographs. Patent No. 10131.

Mr. Day has shown me what he says is the identical length of film.

In these early days a section of film comprised 300 exposures at the rate of ten a second. To-day we have sixteen, which means, after allowing for the action of shutter, an exposure of about one-thirty-second of a second. I have, by the way, a book on *The Cinematograph and Natural Science* by Leonard Donaldson, kindly loaned me by Messrs. Pathe's, in which it is recorded on pages 26-27, that pictures were taken of a dragon-fly in flight at a range of 2,000 per second, the flies automatically photographing themselves. The instrument is a combination "electro - stereo - chronophotograph" and an ultra-rapid camera invented by M. Bull of the Marey Institute, Paris. The interval of time between the taking of the various pictures was gauged by means of a tuning fork, making fifty double vibrations per second, and operating an electro-magnetic signalling device.

1890. Mr Marey constructed a camera and showed this to Edison at Paris Exhibition.

1891-1893 (about). Edison's Kinetoscope appeared.

1895 (July). Display of kinematography given in Paris by Messrs. Lumière with their projection machine and celluloid film. Pronounced a success.

1895 (Oct.). Displayed commercially for first time by Mons. Trewey at Royal Polytechnic Institute, London.

1895. Mr. Robert Paul produced an animated machine projector at Hatton Garden.

1895. Eames filed a specification in U.S.A. for a double lens machine, designed to take two lines of pictures on one film, side by side, the joint between the two pictures on one side being opposite to the centre line of pictures on opposite side—to eliminate unsteadiness.

1896 (Feb.). Displayed commercially at Empire Music Hall, London.

So much for the historical side. It is interesting to note how up-to-date machines bear a close resemblance in certain particulars to these earlier types.

Passing now to present-day practice. In our fight for the improvement of the industry in this country, it is necessary to examine closely into every part of the process of manufacture of the kinematograph film, the apparatus employed, method of its application, and design of buildings, etc., to obtain efficiency and increased production, combined with economy.

Every new venture arouses the interest of the commercial world, more or less, according to the apparent large or small flow of capital—with detrimental results if due care is not exercised in the selection of the most suitable and efficient apparatus to perform the functions peculiar to that venture.

When one considers the magnitude and complexity of a film undertaking, one cannot but appreciate the extraordinary efforts made by the pioneers of the industry in this country.

The Lighting Equipment of Kinema Studios.

There are a number of points to be considered in the lighting equipment of a kinema studio. The essential factors are the actinic values of the various lighting units available, the amount of electrical energy required to operate them, the initial cost of the equipment, and the cost of maintenance.

In the making of a picture film we have to consider the costs involved in photographic and electrical equipment; illumination; film stock; salaries of actors, directors, and mechanics; interest and depreciation charges on buildings and equipment.

The question of illumination and its relationship to the sensitiveness of both the photographic film and the physiological system is now gaining the prominence it deserves.

I think I am correct in saying that the whole of the film industry is eager for information from authorities on the points which I propose bringing forward for discussion—in the endeavour to ascertain the ideal conditions of production.

* These dates mark the period from which the industry, in its present state, started on its career.

The first desiderata to be considered for a studio are the illumination, its manipulation, and the photographic facilities. Then comes the secondary question of housing, which, I submit, is a constructional engineering job.

The engineering side of this industry covers a wide field. What we have lacked in this country is a sufficiency of efficiently designed and equipped studios, the illumination equipment being mobile in every way, with flexibility and ease of control, due regard being paid to safety of all persons and property involved as in factories of other industries. Not infrequently studio buildings have been rushed up and, subsequently, either through lack of capital or foresight, the electrical equipment, the essence of the whole, has been dealt with either parsimoniously, or the building is found to be too low in elevation, too small in area, or too weak in structural details to accommodate the necessary equipment; these shortcomings are apt to be camouflaged by statements to the effect that overhead lights have been found to be unnecessary, etc.

Again, take the question of adequate electricity supply. The amount of electricity demanded may reach a figure too high for ordinary electricity mains networks, necessitating new cables or special generating plant on the premises, perhaps with the ultimate result that no capital is left in reserve to meet the necessary expenditure.

Only those promoters who attack this question boldly on broad, sound lines, by obtaining the advice and guidance of experts in each branch of the industry —in the same manner as obtains in other large industrial concerns—can hope to hold their own. Poor equipment or a staff without adequate training will prove disastrous.

The great strength of the British manufacturer is in his tradition that all his goods and works must be and continue to be of first-grade quality. But extravagance in outlay must be avoided.

A wave of economy is already " setting in " in America. We may find that the six years' " hold up " of the industry in this country owing to the war may prove a blessing, having prevented the materialisation of a certain number of undesirable schemes to the detriment of the reputation of the film industry.

Every up-to-date, well-equipped studio can be its own research department if it will engage experts and allow them freedom of action to deal with any form of apparatus submitted for approval by commercial firms, remembering that it is difficult for one man to be a specialist in every direction of science, etc. And in this business you have a combination of science, arts and industry.

Eyesight Troubles in Kinema Studios.

It is now more than a year ago since the author referred to the possibility of eyesight-trouble in kinema studios, arising from the special lighting conditions employed. The eye has been developed under conditions of natural lighting which involve only moderate intrinsic brilliancies. The accompanying table shows the intrinsic brilliances of various illuminants :—

Source of Light.	Candlepower per square in.
Uniform White Sky	2—5
Oil Lamp	3—5
Mercury Vapour Lamp	15—20
Enclosed Arc ..	100—500
Gas-filled Tungsten Lamp	2,200
Flame Arc	5,000
Open Arc	10,000—50,000
Open arc (crater) ..	200,000
Sun	500,000—600,000

This table alone suffices to show the great differences between the conditions when a film is taken in the open air by the natural light of the white sky, and by powerful arc lamps at close quarters.

There seems to be a general impression that the main source of eyesight trouble in studios, when it occurs, is the exposure to sources of very great intrinsic brilliancy. It is possible that the strong ultra-violet component in some lights, which is highly desirable from the photographic standpoint, may accentuate a tendency to inflammation of the eyes, as it has been remarked in other processes, *e.g.*, in arc-welding, etc. Inflammation or scorching of the skin which accompanies eye-irritation in some cases is also a well-known result of excessive exposure to ultra-violet light. Again, prolonged

exposure to light of a peculiar colour may lead to subsequent derangement of colour vision. Professor Burch, by exposure of his own eye to intense mono-chromatic light, produced disturbances which persisted for more than a year. These are questions on which the co-operation of ophthalmologists is necessary. It seems clear, however, that whichever of the above effects is concerned, the danger of injury occurs mainly when images of great concentrated brightness are formed on the retina of the eye.

There have been reports of artistes suffering from eyesight troubles, which have been ascribed to the effect of exposure to very powerful illuminants. Among other newspaper cuttings on this subject I have an extract from the *Picture Playgoers* (November 22nd, 1919, page 614) showing where several artistes of a film company are affected by semi-blindness, due, it is stated, to the powerful studio lights. The manifestation of this trouble in a severe form in this country seems to have coincided with the importation of certain types of lamps, though it may have existed in a minor form before then, due perhaps to carelessness in manipulation of arc lamps without suitable diffusers.

Again, I have a cutting from *The Bioscope* (July 1st, 1920) stating that: "The effects of studio work upon the eyesight of film artistes was the subject of a paper read by Dr. Chappé before the Société Française d'Ophthalmologie. The painful results of the arc lamps' glare become most acute, according to his investigations, two or three hours after leaving the studio. On his advice one studio has inaugurated a regular system of eye baths for artistes on the conclusion of the day's work."

From both the artistic and human points of view it is impossible for artistes to act naturally under the blinding glare of points of high intrinsic brilliancy with attendant chemical fumes and odours. Producers are endeavouring to overcome the difficulty by providing coloured spectacles for artistes' use during rehearsals, and removing them for the actual "take." But how can you in these circumstances get the correct expressions? The human eye cannot instantly adapt itself to these great contrasts. One trade journal compares artistes with miners, as taking up a career of their own free will and fully cognisant of the risks they run. But up to a certain time were artistes aware of any risk? Also, we must remember, that the miners are protected in every possible way by H.M. Government regulations, and that industrial factory operatives are similarly safeguarded.

I am informed that a "Film Production Studio does not come within the scope of the Factory Acts." For the information of those who may not be conversant with the Acts I might add that certain exemptions are granted to industrial concerns. For instance, ". . . providing *apparatus* is so constructed and protected, and such precautions taken as may be necessary to prevent *danger* . . ." — "*danger*" being defined as "danger to health." Attention is also drawn to "injury which may be caused to the eyes by looking at the arc from some distance away, even only for a few seconds, and therefore it is not only necessary to protect the eyes of actual workers but also passers-by."

In one particular case where I advised on a scheme, I considered it the safest policy to so frame my specification that all requirements of the Factory Acts and other authorities were complied with, including safeguards against fire risk, risk of shock, or burns to persons, which may conceivably arise from trailing cables without adequate protection, or where connections, cables, etc., are not sufficiently large to carry all the electrical current that may be demanded without overheating. I do not know how far the London County Council kinematograph powers extend towards studios. Studios outside the London area of course would not be covered by them.

Apart from the hygienic side of this abundance of light, it is uneconomical for black and white work, a great deal of electricity being wasted in the photographic sense.

Visual and Photographic Effect.

A point of very great importance in the lighting of kinema studios is the distinction between visible light and light of photographic value. For the benefit of those unfamiliar with these technicalities I may, perhaps, explain that

the human eye is generally regarded as being sensitive to light within the wave-lengths of about 0·39μ (violet) to 0·75μ (deep red) (μ being used to denote one thousandth of a millimetre). The maximum luminosity occurs near 0·55μ, corresponding to yellow-green coloured light, but the maximum chemical or photographic effect occurs near 0·415μ corresponding to region, *i.e.*, just outside the visible rays.

For ordinary purposes of illumination the engineer's aim is to convert applied electrical energy into visual wave-lengths with a maximum about 0·55μ, corresponding to yellow-green colour, and, with the least possible amount of waste of the applied energy, an example being the gas-filled tungsten lamp of good visual efficiency at certain voltages. He will then reflect the light rays in the desired direction, the best results being obtained where the fewest rays have to be reflected, as a certain amount is always lost in the reflecting device.

For photographic purposes, however, that is, for, actinic rays, the visual light is practically of no value as a guide. Hence, when I read of studio illuminants quoted as being capable of developing an extraordinary candlepower and taking an extraordinary amount of energy (with the addition of concentrated heat), all to no practical photographic purpose, I wonder what the film industry are doing.

From the photographic standpoint it is desirable (according to Dr. Mees of the Eastman-Kodak Co.) to select an illuminant with an abundance of rays of approximately 0·40μ wave length. I understand that the camera lens is opaque to a certain amount of ultra-violet rays. To attain this result efficiently, he should dismiss the aim of producing an extravagant visual candlepower. The selection of the illuminant would naturally be affected by the selective sensitiveness of the film. (I was recently informed that the Kodak Co. are modifying the sensitiveness of their films and would like to know what difference, if any, is anticipated.) In this connection it is well to recall the remark made earlier, that excess of ultra-violet rays has a prejudicial effect on the eyes. But it is known that all varieties of ultra-violet light are not equally injurious, and it would therefore be a useful inquiry to ascertain whether the rays which are chiefly needed from a photographic standpoint fall within the range of wave-length that is liable to cause eye trouble.

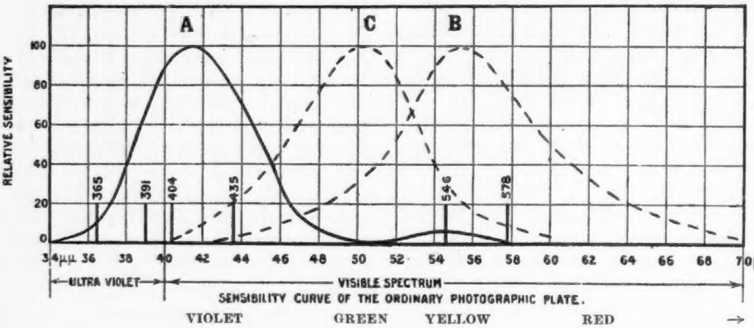


FIG. 1.—Illustrating Photographic Intensity (A) and visual sensitiveness at low illuminations (B) and high illuminations (C), throughout the spectrum.

In view of what has been said above it is clearly of great importance to have available data comparing, not merely the efficiency of illuminants in a visual sense (*i.e.*, for the purpose of creating *brightness*), but their relative value in terms of chemical or photographic effect.

Two or three months ago our Secretary very kindly furnished me with references to records in several American Journals. I find that Dr. Mees, the Director of

Research of the Eastman-Kodak Co. remarks* :—

"For cinematograph work where halation is a difficulty it is an advantage therefore, both for the attaining of the best gradation and for the reduction of halation to a minimum, to use for these ordinary (photographic) materials, light of an average wave-length as near as possible $\lambda = 400\mu\mu$ rather than light having its maximum near $\lambda = 470\mu\mu$." On the next page he gives the following data, applying to ordinary photographic work :—

V. A. Clarke, who observe that the 220 volt arc seems radically different in many of its properties from the 110 volt enclosed arc. While the distribution of light is still practically horizontal the light is of greater intensity because of the long arc stream. From the standpoint of speed these 220 volt enclosed arcs were considered the best in commercial use at that time for photographic work not involving colour-quality. In the *Lighting Journal*, U.S.A. (October, 1915), a chart of actinic values against current consumed, is given :—

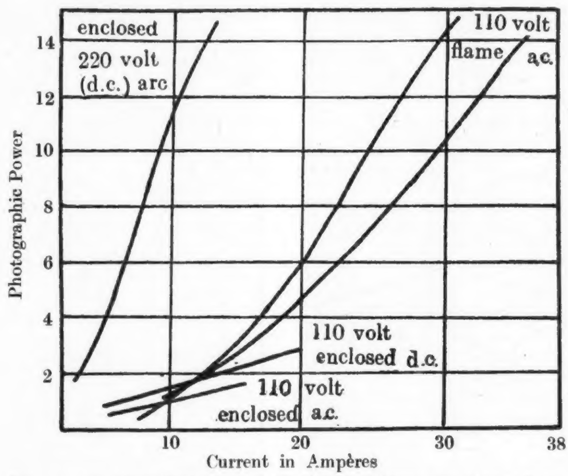


FIG. 2.—American Tests comparing photographic values of open flame arcs and enclosed arcs (length of arc not stated).—(*Lighting Journal*, U.S.A., October, 1915.)

Photographic efficiency—

Enclosed arc as ..	62	Due regard must be paid to electrical current values for each illuminant.
Flame ,, ..	52	
Mercury Vapour (not quartz type, quartz is transparent to ultra-violet rays)	47	

Constancy and steadiness of light—

Arcs	Fair
Mercury vapour	Good

Other data are given in a paper before the same Society by Dr. Mott and Mr.

Source.	Relative Actinic Value.	Current Consumed. Amps.
220 volt enclosed (d.c.) arc ..	15	14
110 volt flame arc	15	31—37
110 volt enclosed arc	2—3	23—24

The effect of increased voltage on the 220 volt arc is clearly demonstrated. Expert photographers have, I believe, confirmed the view of engineers that the enclosure of the carbons and longer arc used accentuates the proportion of ultra-violet light. The lower the actinic value, the greater the number of illuminants

* *Trans. Illum. Eng. Soc.*, U.S.A., Vol. X. 1915, p. 954.

needed and correspondingly greater amount of generating plant.

My attention has been drawn to a comparison carried out by Mr. H. M. Lomas between multiple open type lamps with four pairs of carbons, taking 25 amps. and consuming 5½ units per hour, and certain enclosed arcs with one pair of carbons taking 15 amps. or 3·3 units per hour. Roughly, tests appeared to have shown that the enclosed arc was four times as powerful as the open

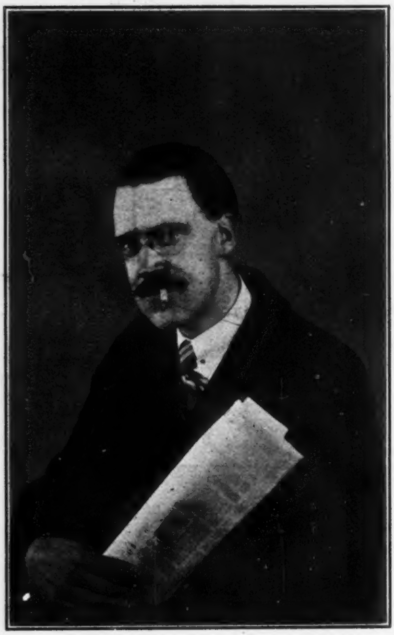


FIG. 3.—Photograph of the Author taken at a distance of 4 feet from one bank of mercury lamps.

type arc, using ordinary carbons; and that the enclosed arc gives at least twice as much photographic light as the multiple open type lamp, the latter using white flame carbons. As regards the photographic rendering of colours, the results with both types of lamps were substantially identical.

Apparently no diffusing screens were used with these arcs. Tests on the effect of such screens would be helpful. Indeed, one would like to see a full series of experiments on the relative photographic efficiency of all the illuminants at present in use in kinema studios.

I recently showed a gentleman whose interest had been aroused a series of photographs taken by artificial light. They were taken by Mr. Basil at the recent Photographic Exhibition at the Royal Horticultural Hall.

He selected the best one, and I then informed him that this was produced by an illuminant using only ¾ of a unit of

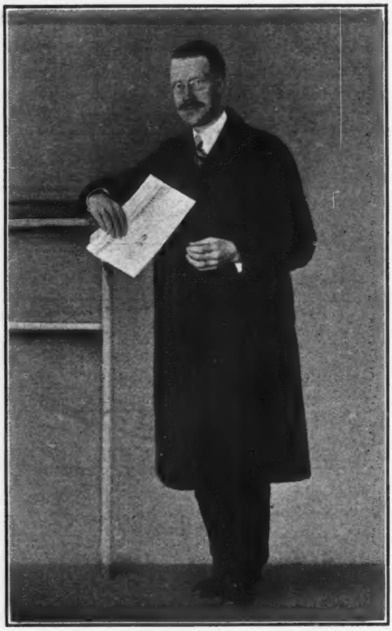


FIG. 4.—Photograph of the Author taken at a distance of 14 feet from three banks of mercury lamps.

electricity per hour, as compared with others requiring respectively 3½ and 6 units. He was naturally surprised.

I may here show two illustrations of some rough tests I have made with the aid of Mr. Percy King as an independent photographic expert. I conducted these tests primarily in view of the statement to the effect that the mercury vapour lamps were of no use beyond 10 ft. or even 7 ft. distance. I should very much like to

be allowed to continue these tests and researches.

Meantime the results of my experiment are shown in Figs. 3 and 4. Fig. 3 is a photograph of myself taken at a distance of 4 feet from one bank of mercury lamps. Fig. 4 is a similar photograph taken at a distance of 14 feet from three banks of lamps. In each case the time of exposure was a quarter of a second and the stop f/7.

and at a distance, two 1,000 candlepower tubes each consuming 3½ ampères being used, the lamps being fixed at a distance of 6 feet from the model. Experiments with a number of other types of lamps were made and the results in this case compared quite favourably with those obtained by other lighting units.

The foregoing results are of interest in view of the highly-diffused character of the light from the mercury vapour

FIG. 5.

FIG. 6.

Photographs taken by light of a 1,000 candlepower mercury vapour lamp at close quarters and at a distance.

As the question has been raised regarding the appearance of faces and clothing in photographs taken by the light of the mercury vapour lamp it may also be of interest to reproduce two photographs taken by Mr. Basil at the 1920 Photographic Fair and exhibited in his lecture on Lighting and Photography. I understand that Mr. Basil had no previous experience with mercury vapour lamps. The two photographs illustrated in Figs. 5 and 6 were taken respectively at close quarters

lamp. Other illuminants also differ to some extent as regards the nature of the shadows, and in Fig. 7 a diagram illustrating the conditions occurring with an open arc and an enclosed arc having a relatively long gap between the electrodes is presented. A tendency to instability of an arc may be expected to affect shadow-conditions and for this reason, as well as for the primary purpose of diminishing possible glare, the use of white backgrounds and light-diffusing screens in front of the source appear advantageous.

Attention has been drawn to the apparent difference in the colour of light furnished by open and enclosed arcs and in this connection the experiment illustrated in Fig. 8 may be of interest. This is a photograph of a series of coloured surfaces, illuminated on the left by an enclosed arc and on the right by an open flame arc. Although a wide difference in colours is represented the photographic effect was substantially the same in both cases.

The Lighting of Scenes in Studios.

The qualities desirable in illuminants for use in kinema studios may be roughly summarised as follows :—

(A) High actinic value with relatively low consumption of energy, and small losses in diffusion, reflection and resistances.

(B) Low intrinsic brilliancy.

(C) Absence of heat or fumes, or other harmful conditions.

(D) Long useful life.

(E) Constancy and steadiness of light.

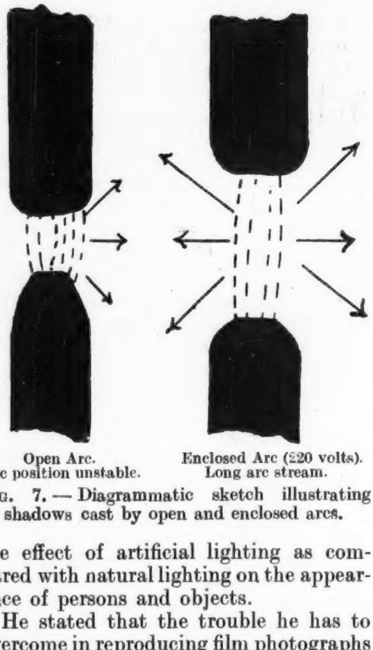
Most of you are doubtless familiar with the usual arrangements of lights in a studio. As a rule the three-sided enclosure in which the piece is acted has a wider width at the front, facing the operator, so that the two enclosing sides slope outwards. Masses of lights are arranged at the front on either side of the stage. It may also be desirable to supplement this front lighting by overhead units. In some cases concealed lights towards the rear of the stage are used to show up the background. The nature of the sides and background is frequently of importance; it may be necessary for this to be relatively dark in tint so that the figures of actors may "show up" in sharp relief. But it would seem desirable to use a fairly light tint whenever possible, in view of the better diffusion of light by reflection and probable reduction in the consumption of energy needed. The colour of the light is also of consequence, as it determines largely the degree of make-up necessary on the faces of actors. I should like to raise the question whether gas-filled incandescent lamps might not sometimes play a subordinate part in studio lighting. While the actinic power is naturally inferior to that of arcs or mercury vapour lamps, there are no resistance coil losses, their use, as a supplementary illuminant, has been recommended for the purpose of correcting colour-values, and it is possible that in some cases, for example, when the stage is exceptionally deep, they would be useful as local lights.

Apart from the selection of the illuminant doubtless much remains to be done in the design of special reflectors and shades, and in the selection of the positions of light, which may have a considerable effect on the energy consumption. The reflectors at present provided have usually a very simple contour, which has possibly not been designed with the same care as that devoted to those used for the illumination of interiors of buildings generally. The back surface is commonly whitened, which gives a diffusing effect desirable for the production of soft shadows, but does not enable much concentration of light in a relatively narrow beam; hence much light may escape outside the actual boundary of the stage where it is needed. It is conceivable that by using a polished reflector, giving a narrower beam, and then subsequently screening this lightly, the desired reduction in intrinsic brilliancy might be gained, without efficiency being unduly sacrificed.

Unequal illumination of sets and artists has been complained of on occasion. This difficulty, I believe, arises mainly when the effect of the law of inverse squares is overlooked. It should be realised that when the distance of an object from the source of light is doubled, the illumination received is reduced to one-fourth, when the distance is increased three times the illumination is diminished to only one-ninth, etc. Due consideration of this law may obviate the necessity of using a large number of high-powered "spot-lights" (which, by the way, are never used when photographs of any special event are taken in daylight—such as street scenes). In general, the greater the distance of lamps from the camera field, the less need to consider the inverse square law, and the less likelihood of artists "walking into the light." It is obvious, however, that the further the illuminants are removed from the scene, the narrower

should be the angle of light emitted in order that rays may not be wasted on parts of the room outside the camera-field. A type of lighting unit permitting an adjustable concentration of light, without undue intrinsic brilliancy, would seem convenient for various types of scene and depths of stage.

While, however, the practice of confining the light in a narrow beam is conducive to efficiency, it must be so contrived as to avoid harsh shadows and excessive intrinsic brilliancy. I recently questioned an artist, Mr. Thos. W. Armes, who is called upon at times to make poster pictures for the film industry, regarding



Open Arc. Arc position unstable. Enclosed Arc (220 volts). Long arc stream.

FIG. 7. — Diagrammatic sketch illustrating shadows cast by open and enclosed arcs.

the effect of artificial lighting as compared with natural lighting on the appearance of persons and objects.

He stated that the trouble he has to overcome in reproducing film photographs for publicity purposes arises from the fact that lights strike the object or the person at different angles and destroy the natural modelling. The characteristics of the features of the person are, in some instances, entirely lost. This is exaggerated by the use of " Spot " lights, the several accompanying shadows shown by artistes can be clearly seen, thereby affecting the natural light and shade, destroying the much-sought-after stereoscopic effect.

One of the chief objections to be taken to modern lighting methods in studios is the use of these " flooding " lights, which impair the artistic qualities of the film-picture. Some producers emphasise " snappiness," " needle-point sharpness," " crispness " as desirable qualities. Picture-goers, however, do not always comment favourably on these extreme black and white contrasts, which are fatiguing to the eyes. The " flood-lights " used to produce these effects involve the concentration of light in an almost parallel beam, as in a searchlight.

In these circumstances the concentration of visible light may be efficient. The same effect may occur in a minor way by

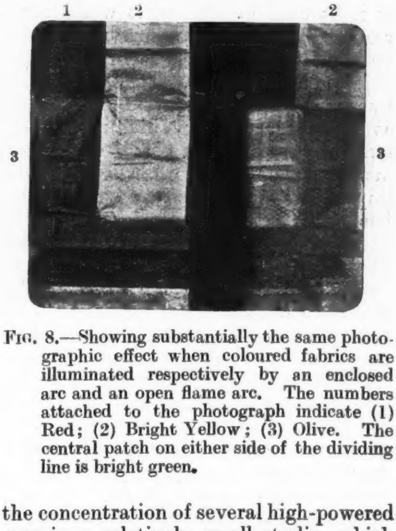


FIG. 8.—Showing substantially the same photographic effect when coloured fabrics are illuminated respectively by an enclosed arc and an open flame arc. The numbers attached to the photograph indicate (1) Red; (2) Bright Yellow; (3) Olive. The central patch on either side of the dividing line is bright green.

the concentration of several high-powered arcs in a relatively small studio, which does not allow of the lights being placed at a distance. But it is obviously better to get the desired result by accentuating the actinic value rather than by the concentration of great amounts of relatively inefficient visible energy.

Why is it that some camera men have achieved excellent results with a few lights, whilst others crave for an abundance of light? Is it because, as was suggested to me, the industry has outgrown the supply of experts, or that the real expert photographer or electrician is not allowed sufficient scope for initiative, being under the control of

a producer or studio manager, who knows what he wants, but, unfortunately, lacks knowledge of photography and electricity?

At the present time one experiences the need of suitable instruments for testing photographic value—similar to those already available for the rapid determination of visible illumination. Present forms of actinometers which involve waiting for the coloration of a strip of sensitised paper are inconvenient and liable to present difficulties to an operator whose eye has already been fatigued by or dazzled by looking at the lights.

Provided that one has definitely ascertained the relative actinic values, for equal illumination, of the chief sources of light used in studios, it would seem practicable to judge exposure by measurements of the actual brightness of the chief objects photographed. This can be done by means of the illumination-photometers available for ordinary illuminating engineering work; it is possible that such measurements would often correct false impressions as to the degree to which backgrounds, etc., are lighted. The values of brightness determined with the photometer would, of course, have to be corrected by the tables for actinic value suggested above.

May I suggest that some definite unit be established to correspond with "lumen," such as "photmen" = photographic value per square foot (we cannot say "phot," or to camera men it would prove confusing) and a suitable instrument devised?

There are, of course, many other considerations in the selection and application of illuminants for kinema studios. There are some who argue that money spent in this way is of no importance where the success of a piece is concerned. Perhaps so, but why spend money uselessly on inefficient apparatus? In America, as I have already indicated, a policy of retrenchment has been found desirable. Wasteful illuminants involve unduly large generating plant and excessive consumption of energy. Maintenance costs of illuminants must also be considered (*e.g.*, mercury vapour lamps require no recarboning, open arcs require recarboning at more frequent intervals than enclosed arcs, etc.).

In the studio as in all other places where light is applied, methods of directing and occasionally shading the light deserve study. In passing I may remark that the suggestion that illuminants using white light should be covered with blue glass cannot be approved. In this way the actinic value for a given visible illumination would doubtless be increased, and possibly the device might tend towards the comfort of actors. But such screening involves a loss in efficiency. One merely absorbs a considerable amount of visible light, and some ultra-violet. What is desirable is to produce a source which itself emits radiation of the requisite quality.

It has been suggested that producers and directors should wear suitably-coloured glasses when setting scenes and rehearsing with the light switched on, in order to be able to judge their appearance when photographed. In one case, a producer agreed that the appearance of a scene by the mercury vapour lamp gave a good idea of its final appearance.

Expert photographers argue that good photography is impossible in the full glare of the sun's high intrinsic brilliancy. without suitable white reflecting boards to soften shadows. Why, then, introduce a large number of artificial suns into the confines of a studio, with their baffling glare, in addition to developing heat?

Photographers generally agree that a uniform white sky—Nature's own diffuser—is the ideal condition. Therefore, why not, when producing exterior scenes inside a studio, imitate diffused daylight as closely as possible, or, if a room scene in daylight, why should not the illumination appear to come through the window and a certain amount reflected from ceiling or room? Not as in some cases, without any ceiling, judging by the "glare" overhead. With a uniform white sky you get soft pictures.

The design of combined artificially lit and daylighted studios is a troublesome question, the camera-man having to repeatedly make adjustments as the daylight intensity alters. I know of at least one company who have daylight and artificial light in separate buildings.

For artificial lighting one requires to be fully informed as to the actinic values

of various illuminants, the most suitable means of diffusion (if required) and reflection, also the best means to make the illuminating equipment as a whole and in parts, mobile, flexible and easy to control. The intrusion of dust, cold and fog, the bugbears of the studio workers, must be provided against by suitable dispelling or preventive and warming apparatus.

Printing Processes.

A few words may next be said on the use of light in connection with the printing of films. After a film has been taken and developed it passes into the printing department, which forms one of the most vital sections in the chain of operations. Inexpert control in printing may mar the good work already done in the production stage by producing foggy positives and uneven light-densities.

The machines used resemble a kinema camera. The negative film, in firm contact with the positive, is passed over an aperature through which the light from an otherwise light-tight box is permitted to reach the positive film. This light is given by an ordinary vacuum type incandescent lamp consuming about 60 watts, and the distance of this lamp from the aperture is controlled and varied as required by a lever conveniently placed outside front of box. For these lights in the printing section it is usual to provide a battery of accumulators to ensure steadiness of illumination. For different scenes the light intensity can thus be adjusted for various densities of printing. The shutter is so timed that it gives the correct length of exposure. An ingenious arrangement is afforded for testing one separate picture exposure at the same speed and under similar conditions to those undergone by the whole film, thus enabling adjustments to be made.

This operation calls for great precision on the operator's part in view of the variations in density, quick action of eye and hand being absolutely essential, otherwise the film may very easily pass from one scene to the next and receive an incorrect amount of light. A large run of valuable film may thus be ruined. Certain novel devices have been adopted to avoid this difficulty, from the automatic buzzer to the complete electrical printer. In the joining of sections of films light is passed through an opaline glass panel from a suitable lamp, thus enabling the operator to see what he is doing and work with accuracy. Some work involves writing titles on a black background. The plates thus prepared are mounted in suitable racks in order that a film may be prepared. This is done in a special self-contained machine.

Conclusion.

In conclusion I may say that I have deliberately avoided very complex technicalities and have made the contents of this paper of a "chatty" character, in the hope that it will lead to useful discussion. A number of highly debatable points have been raised, discussion on which would be helpful to the industry. In particular it is hoped that expert kinema photographers will bring forward some of their difficulties, and give their experience of the effects of various systems of lighting.

In view of the large capital invested in the kinema industry, and the variety of problems that need further research, I would suggest that the Illuminating Engineering Society should adopt the same procedure followed successfully in dealing with other matters, appointing a joint committee in which lighting and photographic experts and representatives of the kinema industry should participate. Co-operation on these lines would be very helpful in clearing up a number of debatable points and suggesting lines of profitable research in this field.

I also wish to explain that the paper was undertaken at somewhat short notice in order that the opportunity presented for a timely discussion on this subject might be utilised. I trust, therefore, that any shortcomings in the material collected will be overlooked.

Finally I wish to add that this collection of information would have been impossible but for the cordial assistance received from many quarters, and to express my great appreciation of the efforts of those who have contributed to its interest by the exhibition of lamps, apparatus, and photographs.

DISCUSSION.

The PRESIDENT, in opening the discussion, expressed his appreciation of the honour of being elected as President of the Society. As an ophthalmologist he was much interested in many of the problems now receiving attention from the Society, such as some of those raised in Mr. Elvy's introductory paper. In these days what was needed, possibly even more than new discoveries, was the co-ordination of existing knowledge. The Illuminating Engineering Society had set a good example in this respect by promoting co-operation in the various branches of the subject with which they were concerned.

He understood that a number of gentlemen had brought to the meeting examples of typical studio lamps and other apparatus, and he would call upon Mr. Wilfred Day to explain some exhibits illustrating very early progress in kinema work.

Mr. WILFRED DAY said the time available for discussion would not allow of a very full account being given of the earlier illuminants which he had brought with him. After the meeting he would be pleased to show and explain in fuller detail some of these early efforts to those who so desired. He had there the first films ever made and the illuminant used to produce them. He called attention to Browning's first arc lamp, which was used in conjunction with a battery of six Grove's cells and drew about $2\frac{1}{2}$ ampères of current, using two sticks of charcoal for the illuminant point. It was semi-automatic in its action. A magnetic detractor allowed the positive carbon to drop and it was checked by a magnetic balance or check-piece. With this lamp Browning issued a notice that the enormous heat engendered at the arc points would seriously endanger the life of the condenser and great care must be exercised in its use. What would a gentleman who read those words say to-day if he saw lamps like that supplied by Capt. Barber at the Albert Hall with 200 ampères behind the condenser ?

An interesting lamp was that produced by Soliel Duboscq. This was his original clockwork arc lamp. It was actuated by a magnetic detractor, which brought into action a release for the escapement, and so fed the positive carbon at double ratio to the negative, and the flame was kept pretty central in that manner. One of the first forms of illuminant was the original Argand oil lamp, which gave 25 candlepower, or 35 candlepower when a reflector was added. But it should be remembered that all slides were then very translucent. He had a box of the original slides with the crystolean painting. He had also brought along the very first arc lamp projector system used by Mons. Trewey in the first public exhibition of pictures in this country, at the Royal Polytechnic Institute in October, 1895, with which was used the water-bottle condenser. He had also the original scissor arc lamp which was operated at that time by Mr. Mat. Raymond, who was present and would bear him out in saying that five ampères was recognised as sufficient current to use with that lamp. He also showed the water-bottle condenser used at that time. But when they came to the Polytechnic and found a 60 ft. throw demanded, they had to increase to 10 ampères. At 10 ampères the water quickly boiled and the springs holding the carbons in position lost their power. So that had to be discarded for displays of a large character, and Messrs. Chard & Co. of Great Portland Street were called on to supply a stage arc lamp suitable to use with 15 ampères of current, which they did, and also supplemented a pair of plano-convex condensers in place of the water bottle.

With regard to the question of illuminants for studio use, it seemed to him that a vast amount of illuminating power was wasted in film studios by the improper application of the light, and if proper reflecting mediums and diffusing screens were used, there should be no danger or fear that sight would be impaired and distress caused to anyone of the vast number of artistes employed on this work. It was remarkable that we had not advanced much on concentrated illuminants suitable for projection purposes since the time of the first public displays of

Lumière's cinematographé in October, 1895. Practically the same type of hand-feed arc lamp, with perhaps a few additional movements, is employed at the present time. He thought it would prove worth while for some of the members of the Society to consider the question of the best lighting medium to adopt with regard to its use in conjunction with kinematograph films. In his opinion we were not using the correct rays for percolating the medium superimposed in the beam of light to exhibit pictures upon a screen. The celluloid film base required certain rays to give the best results, and when consideration was given to the enormous percolating powers of the X-rays, which as an illuminant gives an extremely soft and peculiar light, it certainly sets up a train of thought as to whether either these, or other similar rays, properly concentrated would not be found to give far better results upon the screen, with the use of a much smaller illuminating power than that used at present. Great Britain was the first to start the train of the evolution of the law of persistence of vision as applied to moving objects, in the original data handed down by Dr. Rogêt, F.R.S., in his memoirs published in 1825. Mr. Friese-Greene, a native of Bristol, was the first man to invent and patent a rapid succession of photographs on a band of celluloid film in his patent No. 10,131 of June 21st, 1889. Why should we therefore not strive to achieve the honour of being the first nation to find the correct source of illuminant, best adapted for projection purposes for use in conjunction with celluloid film ?

MR. A. G. WAY (of the Westminster Engineering Company, Ltd.) also promised to exhibit his apparatus more fully after the lecture. The exhibits included a new spot-light with a specially designed "Barkay-Westminster" reflector. The lamp consumed 20 ampères, and the reflector intensified the light seven or eight times on the spot illuminated. The dispersion of the beam of the light was about 15°. He also had the ordinary "Westminster" lamp for overhead and side lighting. The third piece of apparatus was a smaller spotlight in a lantern with iris and condenser.

With regard to the American data shown by Mr. Elvy this was not of much value without knowing the volts across the enclosed arc. If the lamp was designed for 110 volts probably the mechanism would not allow it to adapt itself to the increased length of arc on the 220 volts. The curve, moreover, showed the actinic value of the lamp at 110 volts as only about one-fifth of what it was on 220 volts. On the "Westminster" lamps the efficiency was not less than one-third. There seemed to be something faulty in the condition of the particular lamp shown.

The Author had stated that in the comparative test conducted by Mr. Lomas the enclosed arc was at least twice as efficient as the open flame arc, and he had heard it said that the reason the white light open arc was adopted in America and the enclosed lamp here was that in the early days of electric lighting in America 100 volt circuits were almost universal while in this country 200 volts were readily obtained. The enclosed lamp in this country has always been able therefore to burn to the best advantage.

The superiority of American films at the end of the war was due chiefly to the fact that for three or four years the producers in California were improving their methods and apparatus while we were on war work. Especially during that period they developed spot lighting. In America also they had more capital behind the producing companies, and an ample sufficiency of power in the studio. It was common to have their own plants. To get proper diffusion either by reflection from surfaces, or by using suitable screens, there must be a sufficiency of light. The actual source of the light, as long as it was actinic, was not a great matter. The Kodak film, however, only took account of certain rays, and any other rays produced were of relatively little value.

Considerable progress had been made in this country since the war, and British producers had not now much to learn from American methods. Every day we were making more progress.

MR. F. J. HAWKINS (Hewittic Electric Co., Ltd.) said he had been much interested in Mr. Elvy's paper in view

of the extensive use of the Mercury Vapour Lamps in kinematograph studios. The outfit which they were glad to loan him for his lecture was fitted with eight automatic lighting tubes, which did not require tilting to start, and the total consumption of the outfit was only 14 amperes.

Many of these outfits had recently been supplied to the Alliance, Lasky and Stoll Studios, and, as was evident from the slides shown by Mr. Elvy, the lamps could be raised or lowered and also set at an angle to suit the requirements of the set which was being photographed.

The question of the effect of the light from various studio lamps on the eye was naturally a very important one in view of the recent action taken by the British Actors' Association. He thought that for the benefit of all concerned a thorough investigation should be carried out by impartial and competent authorities, not only on the physiological effects of the various illuminants used in studios, but also as to their actinic values. The usual method of testing actinic values, viz., by means of an actinometer was open to serious error, and in a recent test which he witnessed between 28 ampère unscreened arc lamps and a 14 ampère bank of mercury lamps, the actinometer reading was 30 seconds for the arcs and 60 seconds for the mercury vapour lamps, whereas an actual photograph taken of an object, one side of which was illuminated by the mercury lamps and the other by the arcs showed, as far as the effect on the plate was concerned, there was no perceptible difference. The explanation of this result was that the unscreened arc gave off a lot of ultra-violet light which affected the actinometer, but which was stopped by the camera lens, and was therefore of no photographic value.

No commercial light source gave off as large a proportion of ultra-violet rays as was contained in sunlight. Ordinary lead glass such as was used for incandescent lamp bulbs and mercury vapour tubes absorbed the ultra-violet rays, and many of the troubles supposed to be due to these rays were really due to glare. As many people had the impression that the mercury lamp is particularly rich in ultra-violet rays, he would point out that this was only the case when the tube or burner was made of quartz, as in the equipments which his firm manufactured for use in hospitals and sanatoria for treatment of skin diseases, etc.

In this connection, he added that a series of investigations carried out by Dr. C. H. Williams in New York in 1911, conclusively proved that the light from the lead glass mercury lamp had no harmful effect whatever, and in some cases was actually beneficial to weak eyes, the result of these investigations being published in *The Electrical World*. The lead glass tube mercury lamp as used for works lighting and cinematograph studios required no screen on account of the low intrinsic brilliancy of its light, and on account of its high actinic value there was no question that it was quite indispensable for studio use.

In conclusion, Mr. Hawkins quoted the following extract from Dr. Steinmetz's work on "Radiation, Light and Illumination."

"Hence, green and greenish yellow light are the most harmless, the least irritating to the eye, as they represent the least power. We feel this effect and express it by speaking of the green light as 'cold light' and of the red and orange light as 'hot' or warm. The harmful effect of working very much under artificial illumination is largely due to this energy effect, incident to the large amount of orange, red and especially ultra-red in the radiation of the incandescent bodies used for illuminants and thus does not exist with 'cold light,' as the light of the mercury lamp."

Mr. PULLVER (Duncan Watson & Co.) remarked that America was rather ahead of us as regards studio lighting, and, since spot lighting had developed in the States, overhead bank lighting was dying out.

The disadvantage of gas-filled lamps was that there were considerable breakages. The Americans introduced spot lighting which gave a fine stereoscopic effect on head and faces. If the Americans were retrenching, was it on salaries? He did not think it could be on lighting. Twenty pounds saved on lighting might mean £200 wasted on the film.

Mr. Elvy only touched the fringe of the

question of overhead lighting. In many cases overhead lighting was not used.

As regards flood lighting, very often, too, a picture of an expensively dressed crowd, out on a fine but rather dull day, could only be taken by means of one or two flood lights, or so-called search-lights.

The Americans were again ahead in lamp design, and they produced new designs more rapidly than workers in this country. He was anxious to see new British designs. He believed that there was great scope for further experiment on the part of British producers in the field of kinema studio work.

Added:—If there are any authentic cases of eye-burn it will probably be found that these were due to the misuse of the lamps or to the fact that the type of lamp in operation was not fitted with a diffusing screen. All makes of lamps emanating from the United States would appear to have been primarily designed for the purpose for which they are used, and are all fitted with screens. Most of the lamps made in this country were not in the first place designed for kinema studio lighting and have either an improvised screen or none at all.

I think that if studio managers insisted on the operating staff using the screens provided for the purpose for which they are intended, no trouble would ensue.

Mr. H. A. CARTER said, as was almost natural, Mr. Elvy gave chief consideration to the arc and the mercury vapour lamp, but there was a reference to the possibility of gas-filled lamps playing a subsidiary part in film production. He thought that the Society might be interested in the results of recent experiments with modern gas-filled lamps for illuminating film studios. Modern films were now orthochromatic, that is to say, when exposed in daylight they produced images in which the colours were given their true relative tone values. But these conditions only held good for daylight exposure, and the orthochromatism was of little advantage when the film was exposed under arc lamps, owing to the predominance of blue and blue-violet rays. Gas-filled metallic lamps, on the contrary, were rich in red, orange and yellow rays, and, therefore, produced a light having a composition closer to daylight than that of the arc, with the result that photographs taken on standard orthochromatic films were also more colour-true. Gas-filled lamps were light and easily handled, and replacements could be made quickly. They were steady in operation and the quality of the light did not appreciably vary throughout their life. They had no complicated mechanism, and one electrician could supervise a large installation. No energy was wasted in resistances. These lamps were obtainable for all standard voltages, and, being suitable for alternating or direct current, expensive converters were not needed. If these lamps were installed with large white reflectors behind and suitable diffusers in front the glare would not be any greater than that of the usual arrangement of arc lamps, and it would probably be more bearable on account of its steadiness. The ideal illumination was daylight, but much work must be done under artificial light. The aim of the illuminating engineer, therefore, was to reproduce, as exactly as possible, daylight conditions by artificial means, and the gas-filled lamp would eventually be used very largely in that connection. He would show two lengths of film of identical subjects, one taken under enclosed arc lamps and the other by the aid of gas-filled lamps in studio reflectors. The scene was made as difficult as possible to photograph, the background comprising a highly coloured Indian rug with blue, bright red and green in it, and hangings of deep rose red, and black silk with yellow and gold stripes. The lady in the picture was also a difficult subject, having light brown hair and very light blue-grey eyes.

Mr. R. E. BOARDMAN (Marion & Co., Ltd.) exhibited several forms of studio lamps. Amongst these was a form of indirect unit, the light from a white flame arc being reflected from a matt white surface forming the interior of a reflector somewhat in the shape of an umbrella. The diffusion of light thus produced approached nearer to daylight, was restful to the eyes and produced shadows which were best suited to the

aims of a photographic artist in getting artistic modelling.

The Right Hon. G. H. ROBERTS, M.P. (Chairman of the Ministry of Health Committee on the Causes and Prevention of Blindness), mentioned that the Government Department to whom the question of the effect of the light on kinema artists had been referred had laid the problem before a committee over which he happened to be presiding, and of which the President of the Society (Mr. Parsons) was also a member. His experience, small as it had been, had caused him to inquire whether constant engagement in these studios might not have some detrimental effect on sight. He was there by Mr. Gaster's invitation, and as the Committee were taking evidence during the next few days he thought he might be a little more confident after his experience that evening. He might attend there a little later on, when a friend of his would be reading a paper on a subject with which he (Mr. Roberts) was more or less familiar, and he would then take the opportunity of making a few remarks.

Mr. ALFRED LUGG (General Secretary of the Actors' Association) said he noticed the title of the paper was the "Use and Abuse of Light in Studios." Light in film production was essential, but the abuse of light might become a dangerous thing. When the Committee dealing with the subject met, which he believed they would do the following Monday, he thought sufficient evidence would be given to show that in effect the lighting of cinemas had become a master and not a servant in the hands of some of those who used it. In discussions on processes the technical aspects were emphasised, but frequently the human element was overlooked. His Association had no desire, as organised actors and actresses, to impede the legitimate development of the kinema and the lighting of kinema studios, but they thought that where a light was invented to improve the production of the film and it was proved detrimental to the eyesight of artistes the onus was on the inventor or user to provide safeguards. One of the chief defences of people they had accused was that it was the artistes' own fault. They were provided with coloured glasses. There was an actress present whom Sir Anderson Critchett had described as the stencilled actress, because a perfect imprint of her back was burnt upon her and as a result her back peeled. A light that would cause this effect might have a highly prejudicial effect on the eyesight. The glasses, if they protected her eyes, did not protect her back. He wanted to make it clear that his Association's efforts were all for the benefit of the industry provided there were proper safeguards for the artistes.

Capt. J. W. BARBER said that he was sure that the industry would welcome any scientific investigation on the problems confronting it, and would facilitate experiments thereon. He felt, however, that more information was needed before assuming that injury to eyesight was liable to occur in kinema studios. He (Capt. Barber) had not come into contact with anyone who had suffered in this way, and it would be unfortunate if the impression got abroad that this was a dangerous occupation. It was necessary to draw a distinction between the effect of a light viewed at very close quarters, and its effect when judiciously used for the illumination of a scene in a kinema. It was admitted that people should not stare direct at brilliant sources of light, and there was no need for actors to do so. Mr. Elvy had remarked that with their eyes blinded by powerful lights it was impossible for performers to act naturally. Observations of the films in common use to-day showed that actors could preserve a natural expression, which would not be the case if their eyes were being fatigued by bright light.

With regard to the mercury vapour light, the psychological effect of the peculiar colour should not be overlooked. Some people were liable to become bilious or to be otherwise affected.

He thought that one might accept the conclusion that it did not pay to go to extremes in obtaining a highly actinic light. It might be possible to use a kind of light which, though less efficient, was nearer to nature. Another point to be noted was the special make-up necessi-

tated by the use of the mercury vapour lamp. The colour of this light was so different from that outside the actual area of the performance, where the actors made up, that the effect on the film might be different from what was anticipated. Mr. Elvy had shown that there was a considerable variety of illuminants available for use in kinema studios. Had he formed any opinion as to the form of lamp, or combination of lamps, which it was desirable to use ?

In a kinema studio most of the light came either from the side or behind the actors, whereas in a theatre the actor was faced by the footlights immediately in front. He had never heard that the lighting of the stage of an ordinary theatre had a prejudicial effect on the eyes of actors, although they frequently had several spotlights concentrated on their faces, and provided they were used with reasonable care he saw no reason to suppose that there would be danger arising from the use of such lights in kinema studios.

Captain PAUL KIMBERLEY, O.B.E. (Director and Manager of Hepworth Picture Plays, Limited, and Managing Director of the Imperial Film Company, Limited), remarked that Mr. Elvy had mentioned cases of alleged injury to eyesight, and had quoted as evidence paragraphs that had appeared in certain trade papers, but he had apparently not personally investigated the cases he mentioned to see what truth there was in the reports. Captain Kimberley spoke on behalf of his Company, Hepworth Picture Plays, Limited, whose present studios had been in existence over 12 years, and who had negatives taken 21 years ago. They had several well-known artistes who had been with the Company since they left school, and there had never been a single complaint from any of them. During the past month one of the oldest and best known members of the Hepworth Company had visited a well-known oculist, in company with the Managing Director, because these paragraphs appearing in the trade Press with reference to the danger to eyesight had been noticed, and after a careful examination, the specialist stated that this particular artiste's eyesight was perfect. The Hepworth Company was not aware of any case of injury to the eyes of actors in kinema studios attributable to the special lighting conditions. He agreed, however, that there was still much to be learned in connection with the lighting of studios. Some of them on the film producing side did not claim to have expert knowledge of the electrical side, but by a combination of experts one hoped to arrive at something like perfection.

Mr. COLIN BENNETT said he knew a little about photography but very little about illuminating engineering. He was sure, however, that the main thing to consider in studio lighting was not its engineering but its photographic side. A little light properly used would give a good exposure while a great deal of light wrongly used would give an apparently under-exposed negative. It had been pointed out by the most expert of our living portrait photographers that the more the direction of light was divided up the worse was the result. A unidirectional light was best and it could be achieved in artificially lighted studios. If it were true that daylight was the best light for motion pictures, did it not follow from this that a suitably diffused unidirectional artificial studio light must be better than one compounded of a number of light pencils each coming from quite a different direction ?

Mr. H. M. LOMAS said that there had been much discussion of late regarding the best form of studio illumination.

It seemed to him that this question was closely connected with that of the possible injury to eyesight in studios, for the requisite light for kinematography was not one which most affected the eye, but a light with its region of greatest intensity in that part of the spectrum to which the sensitive emulsion was most sensitive.

A light with an intensity curve which most closely resembled the colour-sensitiveness curve of Kodak negative film stock was obviously what was required (for instance, the light from an enclosed arc lamp), for in this manner one was getting the greatest (photographic) value

out of one's current consumption, and with the least eye strain.

Cases of very temporary eye trouble in studios had certainly come before his notice, but he considered that they had been occasioned by the sufferers having stared at the lighting arrangements of the studios when they were not performing. The only acute case which he remembered was when several unscreened open arcs had to be used at close quarters, and then the effect had terminated in 24 hours.

Mr. S. ROWSON (Ideal Film Co., Ltd.) endorsed Captain Kimberley's observations in regard to eye trouble in studios. There had been no cases of trouble among the thousands of artistes who had worked in the studios with which he (Mr. Rowson) was connected.

The remarks of previous speakers suggested several lines of inquiry. If it were assumed that eye-trouble did arise in studios, they must seek for the cause. Was it due to unduly high intensity of light, or to certain rays in the spectrum of the illuminant ? Or was it due not to light at all but to heat or vapours thrown off by the carbons ?

Sir Anderson Critchett, he believed, had expressed the opinion that trouble might arise from the carbon vapour emitted from the arc lamps depositing on the mucous membrane of the eye. If that were so lighting experts and electrical engineers should be able to devise some method by which such fumes and vapours were drawn off so that they would not come in contact with the eye.

It had also been suggested that the light used should be so selected that the luminous efficiency corresponded with the actinic efficiency of the film or emulsion. Such an inquiry might have important effects on the film production industry. At present work was practically confined to the Kodak film, and a particular form of emulsion which were affected by light in a particular way. If films could be produced with the highest sensitiveness located nearer the region of the spectrum of greatest luminosity it might be possible to utilise illuminants in which the blue end of the spectrum was not accentuated, and even to replace arc lamps by gas-filled incandescent lamps.

Apart from such fundamental questions light was very inefficiently used in studios. It was a question whether 2 per cent. of the light produced ultimately found its way on to the film. Among other questions which deserved attention might be mentioned the varieties of carbons giving the most actinic light, the possibility of selecting electrodes other than carbon, and the width of the gap between the electrodes. He had seen gaps up to 5 inches in length, resulting in a very efficient and highly actinic light. Progress might also be sought in the direction of more diffused light-sources, in the form of lines or surfaces rather than a point.

Mr. PERCY KING said if eye-trouble had resulted on the use of high power arc lamps it might be due to latent visual defects such as were not readily noticed by the person himself but could be detected by examination. Persons suffering from some affections of vision could often not face the sun, unless equipped with coloured glasses. Hypermetropic astigmatism or neurasthenic asthenopia might also cause trouble. In viewing eclipses of the sun no one would look at the sun without having a very dark glass, and the same applied to unscreened arc lamps. When a person complained of headache at the kinema one often found that there was a physical or visual defect of the eye. It would be interesting to get several oculists together to examine so-called cases of injury in studios as soon as they occurred. He recommended that every actor and actress should be examined before entering the studio, in case there might be some latent defect in the eye that might not be noticeable to themselves.

Mr. T. W. ARMES said he had only a short experience of working in kinema studios, but during one week there were two cases of eye trouble, either from the light or the heat; cases were constantly cropping up—even those who were working on the lights suffered.

A great deal of his work was making cartoons, portraits and drawings from photographs. In figure painting or drawing it was difficult to work from photo-

graphs taken under artificial light. All the atmosphere surrounding the figure was lost, and the light from a number of "spot-sources" falling on the face was likely to make the features distorted. When working out portraits of cinema artists recently for publicity purposes, he had a dozen photographs of one man. The first to the last were quite unlike the person, and it was difficult to make anything of a portrait from any of the series. This was because in each photograph the light came from innumerable directions, thereby destroying the natural modelling and casting too many shadows. When the film was shown these different impressions might be superimposed giving an average effect. This, he thought, was the chief defect in a good deal of studio-lighting—the use of too many lights and undue concentration of light. Again, one's eye had constantly to chase the important feature in a moving picture all round the screen and could not find a place to rest; this was because there were too many portions of that particular picture of the same tone—either the composition was bad or the lights were improperly manipulated and arranged.

Mr. L. GASTER (Hon. Secretary) referred to the series of queries which had been prepared by the Society for circularisation, independent of Mr. Elvy's introductory paper. He hoped that these queries would lead to some useful information being obtained from experts on the Continent and in the United States.

The discussion had led to a number of interesting questions being raised, and from his own experience in visiting various studios he was satisfied that there was much to be learned, by interchange of views and by experiment, regarding the methods of applying light in studios. He endorsed the suggestion that the Society should adopt its usual procedure in such cases by appointing a Joint Committee, on which it would receive the co-operation of managers of studios, photographic experts, ophthalmologists and others concerned. He believed that the services of the Society in this respect would prove of great value both to the public and the kinema industry.

In conclusion, Mr. Gaster moved a hearty vote of thanks to the lecturer and the various speakers and exhibitors of apparatus, which those present would now have an opportunity of examining in greater detail.

Professor W. M. BAYLISS (*communicated*):—

I regret that I was unable to be present at the meeting and would like to make a few comments on the views expressed by Mr. Elvy.

There seems no doubt that the fault of pictures under artificial illumination is, from the artistic standpoint, the hard black shadows and brilliant lights. This could be remedied by more diffused illumination. The image of a naked arc should never fall upon the actor's retina. I take it that a certain minimum intensity of illumination is necessary in proportion to the sensibility of the film used, but this could be obtained from a source of large area. Probably the ultra-violet light is the most dangerous to the eye; the constant brilliancy of the visible light is more or less cut off by contraction of the iris, provided that changes of position of the actor do not expose him to intense glare. It appears from E. K. Martin's work that it is only rays shorter than $350\mu\mu$ that are absorbed by the eye-media and therefore dangerous. It seems doubtful whether such rays are transmitted in any important proportion by the glass of the dioptric system of the camera. This requires testing, but, if it is the case, screens of appropriate glass might be interposed between the illuminant and the actors in order to absorb rays shorter than $350\mu\mu$. If the photographic film used is insensitive to red and yellow why not also decrease the intensity of these rays? But have not films sensitised to the visible rays been tested? It seems that economy of light should be effected in this way.

On the whole research is required as to what rays actually reach the sensitised film, what region of the spectrum the film is most sensitive to, and what improvement could be made by the use of so-called colour-sensitive films. No doubt some loss of light is involved in the use of any screens or diffusing systems, but the

gain, both artistically and as regards danger to the eyes of the actors, would compensate.

Mr. W. E. Bush (*communicated*) :—

The author has enlarged on the desiderata of kinema studio illumination, but has not told us what he considers to be the ideal equipment. It is presumed that those actively engaged in the production of motion pictures are quite familiar with the shortcomings of each of the various systems of lighting enumerated and definite recommendations would be of assistance.

Data is given as to the consumption, photographic efficiency, and intrinsic brilliancy of various light sources, but no information as to the amount (say, on a "Watts per square foot" basis) that should be installed. Admittedly, this varies with the nature of the set, colour scheme of interior, etc., but it should be possible to compile reasonably accurate data to cover the most general conditions, just as standards have been established for industrial and commercial lighting.

The author does not approve of the use of glass screens to correct the colour value of white illuminants on account of the slight loss in efficiency which would be involved. In view of the controversy on eyesight injury, I submit that the cost of the extra current required would be well worth while if the risk of visual damage to actors and actresses could be definitely avoided by this means. The use of correctly designed reflectors and their careful location would possibly compensate for losses resulting from the use of screens. After all, the cost of lighting (current consumed) must be infinitesimal as compared with salaries and other production costs, although, curiously enough, it is the former expenditure which is very often the most closely scrutinised.

I have made several tests with gas-filled lamps for this class of work, and although they compare unfavourably, on a consumption basis, with the results obtained from arcs, there should be a useful field for them where portability, ease of operation and simplicity of installation are the main requirements. Research in this direction would, I imagine, produce some useful results, but the active co-operation of both photographer and producer is essential.

In view of the diversity of opinion as to the suitability of the large range of available lighting apparatus, the amount of light required, and the effect on the vision, I think that a lighting expert might advantageously be included in the staff of every studio.

Mr. W. Krause (*communicated*) :—

I should like to draw attention to the effect on the eyes of infra-red rays. Experiments show that in my own case even heat rays from an object at 200° F. tend to cause irritation and fatigue. At the other end of the spectrum irritation of a different kind is produced.

To my mind the chief cause of eye-trouble is the emission of rays of light from below the horizontal and entering the eye direct. This is readily appreciated by anyone travelling over snow at high altitudes with a "sombrero" shading the eyes from the sun. The eye is already protected from light coming from above by the upper eyelid and no relief is apparent until the sombrero is held under the eyes.

A similar effect is doubtless produced in some studios, the light striking the eye at such an angle that there is little protection by the eyelid.

Mr. J. C. Elvy, in reply : I should like in the first place to express my appreciation, which I am sure was shared by others, of Mr. Day's interesting historical exhibit. People to-day are apt to overlook the great difficulties encountered and overcome by these early investigators.

Much of the discussion has turned on the question of possible injury to eyesight through exposure to powerful lights. Capt. Barber, Mr. Kimberley, Mr. Rowson and others have met no cases of permanent injury, but the instances I mentioned seem to show that trouble may arise, and I notice that Mr. Lomas and Mr. Armes have known cases of temporary injury, while Mr. Pullver emphasised the importance of using the lamps equipped with a proper screen, with a view to avoiding possible injury. Further investigation is evidently needed to establish the precautions necessary to

avoid any possibility of injury, but it is admitted that actors should be warned against looking straight at the lights, and that people with some source of weakness in their eyes should not undertake acting under artificial light. There also seems to be a general impression that the majority of film-work could be done without the use of naked arcs of great brilliancy; possibly further study might show that such lights can always be avoided.

Mr. Alfred Lugg has given evidence on behalf of the Actors' Association in regard to the prejudicial effect of exposure to very powerful lights in some cases, and his suggestion that adequate precautions should be adopted is reasonable. Capt. Barber referred to the experiences of actors on the stage, but surely the effect of the small-powered limelights used in the ordinary theatre cannot be compared with that of the spotlights consuming 10-15 kw. used at close quarters in some studios. Mr. Krause's remark regarding the indesirability of strong light entering the eye from below the horizontal should also be noted.

There is doubtless scope for improvements in methods of directing and distributing the light. Mr. Way mentioned the "Barkay-Westminster" reflector, which has the advantage that besides concentrating the light in the desired direction, it reduces intrinsic brilliancy. I should, however, like to know how Mr. Way determined the intensification of light to be seven or eight times. The graphs of efficiency given in my paper were intended to indicate the nature of researches made five or six years ago in the States, such as might be pursued in this country. Mr. Pullver is a believer in the American studio lamps. However, as Mr. Way remarks, we in this country are making progress. Ultimately I believe the ideal studio lamp will be found to be one of low intrinsic brilliancy giving a diffused and scientifically directed light. My views in this respect seem to be endorsed by Mr. Colin Bennett's remarks on the desirable conditions of shadows in artificially lighted studios. Mr. Pullver stated that in America overhead lighting seems to be dying out; this, however, is not in accord with my information.

Mr. Carter's experiments with gas-filled incandescent lamps would be more informing if fuller data regarding the relative positions of sources of light, subject and camera were given. In special cases the close reproduction of tones as they appear by daylight may be necessary. But artificial light costs money, and until we have a film with a curve of sensitiveness approaching that of the eye, exact imitation of the colour of daylight will remain expensive, and the use of gas-filled lamps restricted accordingly. In reply to Mr. Bush's inquiry I may mention that, while it is naturally impossible to give rigid formulæ for the consumption of electricity necessary in studios, I have seen good pictures produced with artificial illumination corresponding to 80-120 watts per square foot of area illuminated.

Mr. Lomas, Mr. Rowson and others have pointed out that the question of efficiency is closely related to the sensitiveness throughout the spectrum of the film used. It is said that the ordinary film is not greatly affected by ultra-violet light and that such light is in any case readily absorbed by the camera lens. But there seems to be difference of opinion on this point, due largely, I believe, to the differences in effects perceptible with different varieties of ultra-violet rays. Rays of very short wave-length are doubtless stopped by the camera lens, and possibly are not of great value photographically. But the ultra-violet rays lying immediately below the visible violet may behave differently. The question is, therefore, to determine which rays, if any, are exceptionally prejudicial to the eye and skin, and which are photographically useful.

As Mr. Hawkins remarks, rays of very short wave-length are also largely absorbed by the atmosphere, the presence of an abnormal quantity of such radiation, necessitating the use of goggles, being familiar to mountaineers, airmen, etc.

Professor Bayliss's remarks on the inadvisability of using naked arcs and the exclusion of harmful rays of wave-length below $350\mu\mu$ are helpful. A point that deserves notice, apart from the effect of rays received into the eye as a result of looking at an arc, is the influence of reflected ultra-violet light. Thus the

National Safety Council of Chicago, in drawing up a set of rules for arc-welding, remark that such light may cause skin-burn; and they accordingly suggest that the interiors of rooms devoted to welding operations should be darkened.

As regards the effect of visible light on the eye, I see that Mr. Hawkins quotes Dr. Steinmetz on the alleged preference of the eye for green and greenish-yellow rays. On the other hand the experiments of Dr. Ferree and Miss Rand presented before the American Illuminating Engineering Society suggest a preference for yellow light. Opinions differ on this point and further investigation is needed.

I have already alluded in my paper to the need for an exhaustive comparison of the chief illuminants available in terms of photographic efficiency. My object was to suggest problems for investigation, and I think that the paper has proved useful in this respect. A Joint Committee on the lines suggested by Mr. Gaster should prove of great value and should be welcomed by the industry, in whose interest it is to have all these points scientifically and impartially threshed out.

THE NATIONAL COMMITTEE ON THE PREVENTION OF BLINDNESS (U.S.A.).

The Transactions of the Illuminating Engineering Society (U.S.A.) for February contain a brief summary of the work of the National Committee for the Prevention of Blindness, formed in the United States about six years ago. It has now approximately 4,000 members and donors. Attention has been devoted primarily to the prevention of loss of sight by infants, to various diseases such as trachoma, to wood alcohol poisoning, preservation of vision in classes at schools, the prevention of accidents to the eyes in industry, etc. In a handbook on the latter subject, published in 1917, attention is drawn to the necessity for proper lighting in factories.

The consideration of eyesight in schools has also been energetically taken up, and a manual on this subject has been prepared by Mrs. Winifred Hathaway, secretary of the committee; in this manual much space is devoted to the question of proper methods of lighting in schools.

Throughout its work the committee is in close touch with the American Illuminating Engineering Society, and at the last meeting of the committee an address on proper methods of illumination in relation to the use of the eyes was delivered by Mr. H. F. J. Porter.

THE LIGHTING OF KINEMA THEATRES.

Mr. L. A. Jones, in the Transactions of the American Illuminating Engineering Society for December, 1920, makes some useful suggestions on the artificial lighting of kinema theatres, based on experiment. It is concluded that the illumination at seat-level may attain 0·2 foot-candles at the back of the theatre, gradually diminishing to 0·1 foot-candles near the screen. Such an illumination, besides assisting attendants in their duties, diminishes the extreme contrast between the brightness of the screen and that of surroundings, and thus lessens any tendency to eye-strain. The use of a screen set well back on the stage, and thus partially shielded from diffused light, would probably permit even higher illuminations to be employed.

It is suggested that the contrast between the lightest part of the picture and the surrounding frame should not exceed 1000 : 1 (preferably 500 : 1). The border should therefore be of grey material.

The brightest object (outside the picture) visible from any seat in the theatre, should not exceed in brightness 2·5—3 millilamberts.*

* Roughly 2·5—3 ft.c. surface brightness.

INDEX, February, 1921.

"NORTHLIGHT" STUDIO ARC LAMPS.

IN the course of a recent visit to the studios of Messrs. Marion & Co., Ltd., we had an opportunity of seeing the "Northlight" arc developed by this firm for photographic studio work, which has some interesting features. The lamp is indirect in principle, the actual arc being screened, and its light diffusely reflected from the white interior of an umbrella-shaped device, giving a soft diffused effect which is considered excellent for studio work. Larger units are being developed which it is expected will prove particularly suitable for cinema studio illumination.

For ordinary portrait work somewhat similar units equipped with gas-filled incandescent lamps are used. An interesting development is the use of a special lilac-tinted surface for the interior of the reflector. This diminishes, in quite a striking manner, the apparent brightness of the interior of the reflector, which can be brought quite near the face of the person to be photographed ; but is stated to have relatively little effect on the photographic value of the lighting unit, owing to the fact that it is mainly the non-actinic (red and orange) rays that are suppressed.

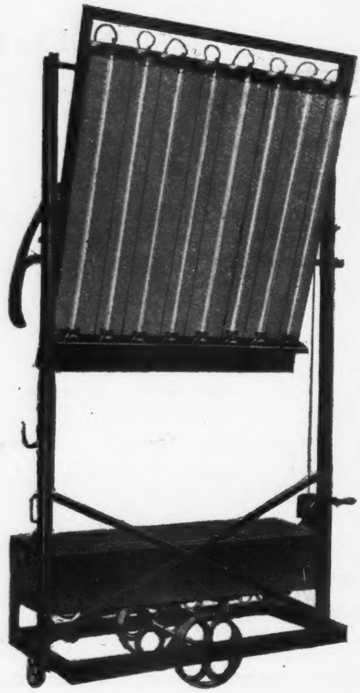
Another simple portable unit which is useful for portraiture is a small enclosed arc, equipped with an ordinary lamp shade so as to resemble a table stand lamp in appearance. On one side the shade is cut away and replaced by a translucent diffusing surface so as to allow the light to play on the face of a person seated at the table, enabling a photograph with quite a small exposure to be made. Other special lighting devices are available to facilitate the inspection of negatives and the making of prints, and here again the method of arranging the light is of considerable interest to the illuminating engineer.

DEVELOPMENTS IN MERCURY VAPOUR LAMPS.

THERE are several developments in mercury vapour lamps during recent years that may have escaped notice, one of these being the automatic method of starting now employed. Tubes can, of course, be readily started by rocking by hand. But in modern lamps starting takes place automatically on switching on The bulb at one extremity of the tube is coated with metal, forming one side of a condenser. At the moment of switching on this condenser discharges, ionising the space adjacent to one of the electrodes and enabling the main electric discharge through the length of the tube to take place so that the lamp lights up.

Our attention was drawn to this device on the occasion of a recent visit to the Hewittic Electric Co., Ltd., when various special forms of lamps were examined. The illustration shows a typical bank of tubes as used for kinema work.

The quartz tube lamp, if used for ordinary lighting purposes, is invariably screened with a diffusing outer globe to absorb the ultra-violet rays. In the lamps for medical treatment the quartz is enclosed in a metal sphere having an aperture through which the ultra-violet light can be focused. An interesting experiment was performed to illustrate the great difference between the quartz tube light and the ordinary glass tube, in regard to emission of ultra-violet rays. A sheet of special glass, practically opaque to visible light but pervious to ultra-violet, is placed in front of the lamp. Behind this is placed a slab of uranium glass which fluoresces by ultra-violet rays. In the case of the ordinary mercury vapour tube the fluorescence becomes inappreciable when it is withdrawn only a few inches away. In the quartz tube lamp, on the other hand, not only is the fluorescence at close quarters much more vivid, but the effect still persists when the uranium glass has been withdrawn a distance of several feet. This experiment also serves to indicate the development of stable conditions in the quartz tube; when the lamp is first switched on the fluorescence is relatively weak. It is only after time is allowed for the lamp to reach its final temperature that the full effect is perceived.



Typical Kinema Floor Stand comprising bank of mercury vapour tubes.

METAL CEILING ROSES.

IN view of the difficulty of obtaining adequate supplies of porcelain the General Electric Co., Ltd., have introduced a metal covered ceiling rose, with a moulded insulated base. The stamped iron cover is cream-enamelled so that the surface generally resembles porcelain in appearance. The base is stated to have high insulating properties, and to be non-hygroscopic, and also to be fireproof, being stoved at a temperature of 450° F. Another feature claimed for this ceiling rose is that it is practically unbreakable. It is also stated to comply with the Institution of Electrical Engineers' Rules, and to have been approved by the Phœnix Assurance Co.

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EDITORIAL.

The Use of Light as an Aid to Publicity.

Successful advertising, it is commonly said, depends essentially on the appeal to the eye. Naturally, therefore, the use of artificial light may be expected to play a great part in publicity methods, two of the best examples being its use for the illumination of shop-windows by night, and its application in the form of illuminated signs, both for advertising purposes and as a means of conveying information.

These two aspects of the use of light as an aid to publicity were introduced by Capt. E. Stroud and Mr. E. C. Leachman respectively at the meeting of the Illuminating Engineering Society on February 25th, and attention was also drawn to the possibilities of illumination in connection with spectacular effects and the lighting of exhibitions. The chief point emphasised in the discussion was the desirability of dealing with this variety of lighting on a uniform plan, giving due weight to all the different aspects and the various sections of the community concerned. In order to be successful in its object, advertising and spectacular lighting must have a striking effect—it must arrest attention. But, as Mr. Leachman happily phrased it, the object should not be to startle, but to attract. In some cases efforts have been made to attract attention by mere brilliancy of the lights exhibited. This method has obvious drawbacks. Very

glaring displays of brilliant lights may attract notice, but the impression they produce is displeasing and they are apt to arouse objections on the ground that they are inartistic and obtrusive. Moreover, the indiscriminate use of unscreened brilliant lamps, either in a shop-window or in a luminous sign may be prejudicial to adjacent displays ; a really pleasing and artistic device may be lost in the blaze of masses of lamps in the immediate vicinity.

In the interests of advertisers as a whole, therefore, it is desirable to discourage the use of large numbers of unscreened lamps ; co-operative effort should ensure that full justice is done to each advertiser. A movement in this direction would also be beneficial to advertisers inasmuch as it would placate the hostile section of the public. Artistically contrived displays and the skilful use of diffused light add to the cheerfulness of streets and improve the appearance of a city by night. The diffused light from concealed shop-lighting and illuminated signs of moderate brightness forms a valuable supplement to street-lamps ; whereas the exposure of unscreened lamps and over-brilliant flashing devices may be distracting to drivers and prejudicial to the safety of traffic. Finally, it must be remembered that a process of using glaring lights is apt to be cumulative—that is, each exhibitor imitates the effects of his neighbour until the general level of brilliancy is raised, when a still brighter effect is needed to attract attention.

It is, therefore, much better, in endeavouring to enlist the notice of passers-by, to aim at ingenious applications of light, arresting effects of contrast, and pleasing colour combinations. Mr. Leachman advocated the development of the artistic pictorial sign, and other novel effects were shown at the meeting. Captain Stroud also showed a number of examples of pleasing show-window lighting, all based on the fundamental principle of using the light to illuminate the contents of the window, the actual sources being screened from view. This method of lighting was advocated by the writer in an article in one of the chief drapery journals many years ago. Representatives of a number of leading stores criticised his views at that time, contending that brilliancy of effect was essential in order to attract custom. To-day, however, these stores, in common with other leading establishments, have become converts to concealed lighting. It is interesting to note that the precautions laid down in regard to window-lighting during the war, as a precaution against visits of hostile aircraft, namely, the shading of lights in directions facing the street, were in substantial accord with the principles that the study of illuminating engineering has shown to be desirable. The opinion was frequently expressed at the time that this diffused method of lighting was a great relief as compared with the exposure of unscreened lamps in windows. The wider use of gas-filled electric lamps for window-lighting since the war has made the need for shading even more important, and as suitable reflectors are now stated by manufacturers to be available in sufficient quantities it is to be hoped that eventually the glare from unscreened lamps placed amongst the goods will become a thing of the past.

Exhibition and Spectacular Lighting.

It is evident that successful spectacular lighting demands co-operation, both on the part of advertisers and the general public. It has accordingly been suggested that in various cities committees should be formed, on which prominent traders and advertisers and the local authority should be represented, in order to secure uniformity of practice. The efforts of such a committee would naturally not be unduly restrictive; it should indeed encourage the judicious use of illuminated signs and display lighting. It would, however, check the indiscriminate use of unscreened powerful lamps at low levels, and the employment of flashing signs of great brightness in places where their effect is considered objectionable from the traffic standpoint or offensive to good taste. As regards public streets it would naturally require some perseverance to bring the various parties into co-operation, but the possibilities in this direction are very much greater than they were a few years ago. We observe, for instance, that a movement for the creation of a uniform traffic authority throughout London is now receiving the support of the L.C.C. This step, which we have advocated in the past, would greatly facilitate uniformity of action in regard to lighting in the streets.

In the case of exhibitions, co-operation in lighting should present no great difficulties. It was remarked by several speakers in the discussion that the lighting conditions in exhibitions are commonly hastily devised and without evidence of any ordered plan. Each exhibitor is a law unto himself, with the result that pleasing and artistic displays, involving the use of diffused lighting, are frequently masked by the glaring effect of the methods of their neighbours. In the interests of exhibitors this is clearly inadvisable. Just as it is assumed that each exhibitor is allowed equal opportunity to display his goods in proportion to the space occupied and paid for, so should he also be afforded equal facilities for so lighting them that they can be seen with ease and comfort. While, therefore, each exhibitor would naturally be allowed freedom to adopt the lighting methods he desired, and would reap the reward of legitimate ingenuity and artistic skill in this direction, it would be a great advantage if some simple general rules restricting the use of over-brilliant unscreened lamps within the direct range of vision could be applied by the organisers of the exhibition.

In the general lighting of the exhibition an attempt should also be made to follow some ordered plan, giving a uniform and pleasing effect. The avoidance of all glaring sources would be a great gain to the public whose eyes are apt to be wearied by the display of a multitude of bright points of light, and whose interest in the exhibits is accordingly relaxed.

There is room for more enterprise in the use of illuminated signs throughout an exhibition with a view to enabling visitors to locate quickly any particular stall. Different sections might, for instance, be mapped out by the use of varied colours. A corresponding large illuminated plan of the exhibition, with the different areas clearly defined and indicated by appropriate colouring, might be placed in the entrance hall. Finally, the possibilities of spectacular lighting, especially in the case of exhibitions with large open areas, deserve much fuller study. The remarkable effects secured at the Panama-Pacific Exhibition* were obtained mainly by the use of concealed lighting and colour-harmonies, and there is no reason why similar methods should not be successfully used in this country.

* Illum. Eng., July, 1915.

The International Students' Union.

More than two years have now elapsed since the Great War. The process of recuperation, as might have been foreseen, has naturally been gradual and in particular the restoration of full intercourse between the countries concerned (even those co-operating in a common cause) still presents difficulties. The recuperation of the world after these years of conflict depends very largely on the existence of a friendly understanding between nations—not merely friendship between their governments and official representatives, but mutual knowledge and tolerance between the individuals of nations. Such relations are difficult to establish in later life when ideas have become fixed. The best hope of the growth of the spirit of brotherhood lies in the future generation, and in the intercourse between young people in different countries who are on the threshold of life and whose minds are open to impressions.

We are, therefore, very pleased to observe the progress of the International Students' Union, a conference of which is to take place at Prague on March 27th–April 7th. We understand that a society with similar objects, the "Corda Fratres," was in existence before the War, and after the Armistice it has been revived, a leading part in the new International Students' Union being taken by France, Belgium and Czecho-Slovakia. Most of the other chief countries of Europe have also given their adherence. We understand that Great Britain and the United States are now prepared to take an active part in the movement, and that a considerable number of British students will take part in the conference. The formation of a national students' union in a country appears to be a necessary preliminary to full membership in the International Union. It is interesting to note that a Scottish Students' Union has been in existence for many years and that in England a similar body is now being developed. All countries admitted to the League of Nations are eligible, so that ultimately all the chief countries, not only in Europe, but throughout the world should be included.

We have no doubt that students in this country will take a leading part in this promising movement. The present conference is being appropriately held in Prague, the seat of one of the oldest universities of Europe, and this fact is a justified compliment to the educational enthusiasm of the newly-constituted Republic of Czecho-Slovakia. The geographical position and traditions of Great Britain, however, are such as to make this country very favourably situated in dealing with wide international movements, embracing East and West, and the choice of London as the ultimate headquarters of the movement would apparently present distinct advantages.

The aim of the movement is to bring students together and promote their general welfare, and particularly to arrange visits, exchange of publications, international sports, etc. It will doubtless help to smooth away many of the difficulties of students resident abroad and should encourage courses of study at foreign universities. Besides being extremely beneficial to the students themselves the interchange of thought thus promoted should be helpful to the progress of science and learning. One of the most unfortunate results of the War has been the unavoidable restriction of exchange of knowledge between scientific men of different countries, and it can scarcely be doubted that progress has been impeded by this situation, which we have reason to believe will be rectified in the near future.

LEON GASTER.

TRANSACTIONS

OF

The Illuminating Engineering Society

(Founded in London, 1909.)

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

THE USE OF LIGHT AS AN AID TO PUBLICITY.

(Proceedings at the Meeting of the Illuminating Engineering Society, held at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C., at 8 p.m., on Thursday, February 24th, 1921.)

A MEETING of the Society was held at the House of the Royal Society of Arts, 18, John Street, Adelphi, W.C., at 8 p.m. on Thursday, Feb. 24th, as stated above, the Chair being taken by Mr. Justus Eck. The Minutes of the last meeting having been taken as read, the Hon. Secretary read out the names of the following applicants for membership :—

Bennett, C. N.	Kinema Expert, 1 Cambridge Place, London, W.2.
Bishop, W. A.	Asst. Distributing Engineer, Croydon Gas Company, Croydon.
Boardman, R. C. ..	Electrical Engineer and Kinema Expert, 1, Beverley Road, East Ham, Essex.
Cachemaile, H.	Director and Manager of the Hewittic Electric Co., Ltd., 80, York Road, King's Cross, London, N.
Engelke, W.	Kinema Expert, "Carfax," Blenheim Road, St. Albans, Herts.
Hawkins, F. J.	Engineer, Hewittic Electric Co., Ltd., 80, York Road, King's Cross, London, N.
Hearson, J.	Electrical Engineer, Corner House, Lance Road, Harrow.
Lomas, H. M.	Kinema Expert, 16, Hamlet Gardens, Ravenscourt Park, London, W.6.
Luckcock, A. H. ..	Manager Electrical Equipments, Ltd., 80, Bedford Street, North Shields.
Murray, E. T. R. ..	Consulting Engineer, "The Eyrie," Radlett, Herts.
Vergne, A. A.	Maker of Electrical Signs, etc., 5, Cromwell Road, S. Kensington.

The Hon. Secretary also read out again the names of applicants announced at the last meeting, and these gentlemen were formally declared members of the Society.*

The CHAIRMAN, in opening the discussion, mentioned that Mr. Sydney Walton, who was well-known as an expert on publicity, had consented to preside at the meeting, but had been unavoidably prevented by indisposition.

The Chairman then called upon Captain E. STROUD to read his introductory paper on **"Show-window Lighting."**

* ILLUM. ENG., Feb., 1921, p. 31.

Captain Stroud's paper, which was illustrated by lantern slides, showing a variety of typical lighting installations in stores, emphasised the importance of avoiding the glare from unscreened sources of light placed in the direct range of vision of people observing the contents of show-windows. Lighting should be effected by concealed lamps, in appropriate reflectors, placed along the top edge of the window. Various precautions necessary to secure adequate well-distributed light were explained, and it was pointed out that properly illuminated show-windows formed one of the cheapest methods of advertisement.

Mr. E. C. LEACHMAN was then called upon to deliver his introductory paper on **"Illuminated Signs."** The lecturer pointed out that many unduly brilliant flashing signs defeated their object. Effective publicity was best obtained by novel and artistic devices rather than by aiming at great brilliancy and masses of lights. Pictorial signs in particular were capable of artistic treatment, and great advances had been made in the method of depositing colours on transparency signs, giving striking and highly luminous effects. Besides their use for advertising, signs fulfilled many important functions in giving information to the public, *e.g.*, as notices used on the railways, for indicating numbers of houses and names of streets, etc.

Both lecturers emphasised the need for concerted action on the part of advertisers, with a view to preventing the display of one advertiser being prejudiced by the exposure of very bright lights by neighbours, and also in order to reconcile the requirements of advertisers with those of the public and avoid interference with street traffic. It was pointed out that there was great scope for improvement in the lighting of exhibitions; where such concerted action could be readily arranged, each exhibitor having due latitude allowed in the arrangement of his lighting but some general rules adopted whereby the inconvenient glare from exposed bright lights would be eliminated.

At the conclusion of his lecture, Mr. Leachman exhibited a number of transparency pictorial signs, drawing attention to the brilliancy of colouring secured. Mr. E. T. RUTHVEN MURRAY showed a form of sign consisting of a glass plate with a concealed tubular lamp along its edge, such that lettering stencilled in white on its back appearing brilliantly illuminated. Mr. R. F. WHITE showed several signs embodying special colour-changing devices, and Mr. A. W. BEUTTELL exhibited signs in which stencilled letters received light from a special curved white surface, illuminated by lamps at one extremity, such that even illumination was obtained. Mr. J. W. FIELD showed some signs, making use of kaleidoscopic effects.

Mr. A. CUNNINGTON (L. & S.W. Ry.) referred to the various applications of illuminated signs on railways, including the lighting of station name-plates, and Mr. S. G. ELLIOTT (Underground Railways, Ltd.) discussed some of the methods employed on the tube railways, and illustrated a good example of flood-lighting at Sloane Square.

Mr. L. GASTER recalled his experience when advocating the use of concealed methods of lighting for show-windows many years ago. At that time representatives of the leading stores criticised the views expressed; but to-day the advantages of such methods of lighting were generally recognised. Show-window lighting had been the subject of reference at past meetings of the Society, and importance had always been attached to the shielding of powerful lights so as to strongly illuminate the contents of the window and avoid the distracting effects of glare.

Among others who took part in the discussion were: Mr. J. C. ELVY, Mr. H. SEAL (Display Manager, Messrs. Selfridge's, Ltd.), Lady KATHARINE PARSONS, Mr. L. M. TYE, and Mr. W. G. RAFFÉ.

After a vote of thanks to exhibitors and speakers the CHAIRMAN announced that the **next meeting** would be held at 8 p.m. on **Thursday, March 17th,** when a discussion on **"Motor-Car Headlights, Ideal Requirements and Practical Solutions"** would be opened by Major A. GARRARD.

THE USE OF LIGHT AS AN AID TO PUBLICITY.

(A) SHOW-WINDOW AND SPECTACULAR LIGHTING.

By Captain E. STROUD.

(Introduction to a discussion which took place at the meeting of the Society held at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C., at 8 p.m., on Thursday, February 24th, 1921.)

Introduction.

SHOW-WINDOW lighting is perhaps the most important means in attracting custom to business premises and is also the most inexpensive. Good show-window lighting has enormous advertising value and is one of the first essentials of good salesmanship. The show window has been called the "Silent Salesman."

The main attraction of a business thoroughfare consists in the individuality of the show windows, and their efficiency is in direct proportion to the art and originality of the dressing and effectiveness of the lighting. This is appreciated by the managers of many of the leading stores, but there are, nevertheless, at present many show windows which suffer from a surfeit of light, a superabundance of improperly equipped and placed units which dazzle prospective customers and make them turn away to exclude the glare from the eyes.

The Disadvantage of Bare Gas-filled Lamps for Show-window Lighting.

Gas-filled lamps of high intrinsic brilliancy have been introduced in relatively large quantities since the war, but they are apt to be installed without due regard as to their suitability for the existing fittings; nor are they so placed as to fulfil the purpose for which they were bought, that is, to give better illumination on the display of goods. In many thousands of cases bare gas-filled type lamps are hung dangling in the window at eye level which makes it a physical impossibility to observe the contents of the window in comfort owing to the extreme contrast between the brightness of the lamp filament and the comparative darkness of the goods on show. Furthermore, if for no other reason that the wastefulness of such methods in current consumption in relation to results were appreciated, great alterations might be effected in such installations to the mutual benefit of the merchants themselves and also to the public.

To appreciate the wastefulness of the bare lamp when used in this manner one must consider the distribution of the light given from the unscreened lamp. Approximately 50 per cent. of the total light emitted is sent in an upward direction and, what is probably even more important, a large proportion of the light is thrown *outwards.* Such light can never under any circumstances illuminate the display for which it was intended. The accompanying diagram illustrates the light distribution of a bare lamp, the shaded position showing the wasted light, which is at least 60 per cent. of the total output from the lamp.

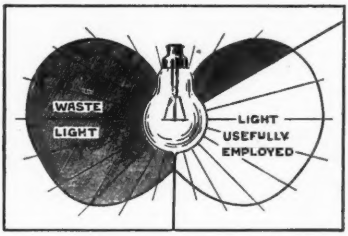


Fig. 1.—Showing proportion of light from an unscreened gas-filled lamp usefully employed and wasted in show-window lighting.

The fundamental principle of show-window lighting which is adhered to in many of the leading stores, but is not complied with in many others, is that the light should be directed on the contents of the window, the actual sources of light being concealed from the view of persons outside the window. The principle is

similar to that universally applied on the stage, which forms an illuminated picture, all bright filaments, etc., being screened from the eyes of the audience. The use of appropriate reflectors with the lamps used not only serves to keep the filaments out of view and eliminate glare; it is also necessary to secure the correct distribution of light—to concentrate the rays where they are needed—thus correcting the natural distribution of light from the naked filament, which, as indicated above, is not well adapted to the requirements of show-window lighting.

The Use of Lamps with Proper Reflectors.

It should be emphasised as most important that lamps should only be used with the form of reflector designed for use with them. For example, one sees instances of the installation of gas-filled lamps in fittings which were designed for vacuum type lamps. There are also cases where correctly designed reflectors are used with fittings or galleries suitable for 40- or 60-watt vacuum lamps, but quite unsuitable for gas-filled type lamps with their much longer neck and larger size; accordingly, when such lamps are inserted in the fitting, the filament is allowed to project below the bottom level of the reflector. One may also meet the converse condition when a lamp filament falls too far inside the reflector. In this case the accentuation of glare does not arise, but the correct distribution of light may be radically altered. Such arrangements defeat the object for which the higher candlepower lamp was installed, and in most cases, if a few shillings were spent on suitable galleries to meet the new conditions, vastly increased illumination would result at very small cost.

Concealed Lighting from Lamps placed along Top Edge of Window.

Experience teaches us that the best effects in show-window lighting can be obtained by placing lamps with suitable concentrating reflectors near the window glass, at the top of the window. The units should be so arranged that they are entirely concealed from view. Concealed lighting does not mean the placing of a shallow curtain or valance in front of lamps so that they are not visible from across the street, but come into view at close quarters; it implies that lamps are concealed in such a way that it is practically impossible to observe the actual light sources regardless of the point of observation. Provided this condition is complied with there is no objection to the use of a mildly luminous curtain or sign bearing the name of the shop, which receives a relatively small amount of the light from the lamps used. Indeed, such a luminous sign attracts the attention of a customer seeking a shop from a distance, and is supplementary to the illumination of the goods to which attention is devoted when the prospective customer arrives.

A considerable number of the more important shops in London are now illuminated by the method of a row of lamps with admirable reflectors placed at the top of the window. But there is not infrequently some distracting feature, such as the fact of the units being visible to an observer when close up to the window, or, what is more common, inconvenient direct reflections of lamps in some form of polished background of the window. In many cases the background is formed either of actual mirrors, polished woodwork or clear glass transomes to allow for the natural lighting of the shop interior in the day-time. The effect is to produce images of the lamps at the back of the window which tend to destroy the effects of the valuable lighting scheme installed. The best method of avoiding both a direct view of lamps at close quarters and inconvenient reflections is to place the front curtain at such a depth as to limit the visual angle so that the direct rays are cut off from the observer close to the window; and a second curtain behind the lamps which acts as a cut off, obviating the annoying reflections from the background and also hiding the lamps from the view of those inside the shop.

A second mistake, which is commonly made in the design of such lighting installations, is the continuing of the row of top lights along the side windows to the entrance. In these cases, although the front row of units are more or less concealed the side row are in the direct line of vision and give a distracting effect which nullifies the lighting effect to a very great extent. In cases where the show-

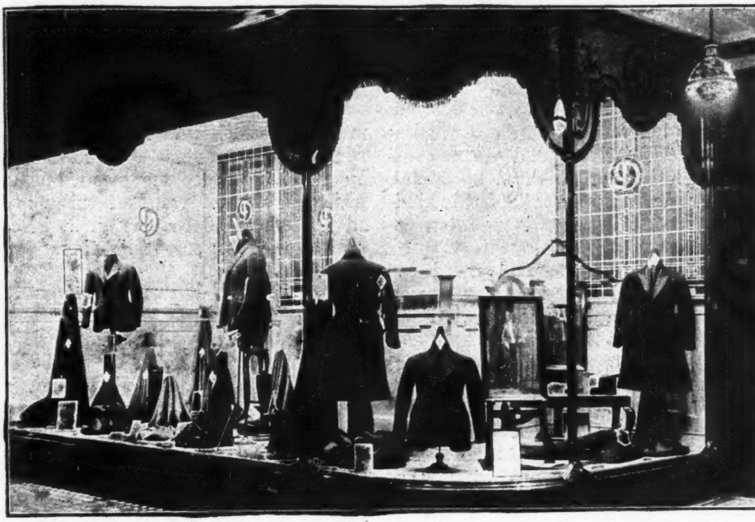


Fig. 2.—Typical overhead concealed lighting of a show-window (Messrs. Dolands, Victoria Street, S.W. 1).

window is adjacent to a side or central entrance to a shop concealment of the front lights may be effected by draping short partition curtains between the units forming an open bottomed box for the units.

Reflectors are designed to give varied distribution of light, and it is possible by employing reflectors giving the coirect light distribution to adequately illuminate any window from a front row, whether the window be high or low, deep or shallow. The correct spacing of the reflectors to give the desired effect is based on a knowledge of the light distribution from individual units. Hence the desirability, as indicated above, of ensuring that these distributions are not interfered with by inserting lamps of such a type that the filaments fall in the wrong position with regard to the reflector.

I have a number of lantern slides showing various modern shop window installations which bring out the points so far discussed.

Fig. 3.—Effective lighting of a clothing store (Messrs. Hope Bros.).

Relation of Lighting to Method of Dressing Windows.

The whole effectiveness of window lighting depends upon contrast and to possess advertising value must attract. The two factors in window displays are of course the effectiveness of the window dressing and the light by which it is seen. Window dressing and lighting should be

considered together in order to obtain the best effect. It may be remarked, however, that good window lighting in itself is an attraction. A strikingly lighted window will bring people right across the street even before they can observe its contents; whereas a good display of goods which is poorly lighted has practically no "drawing power" of this kind and may even fail to hold attention at close quarters.

The argument has been advanced by shopkeepers that they must have hanging bare lamps in their windows because they dress their windows closely (so closely, in fact, that in some cases they actually attach articles to the window glass!). It is impossible to light efficiently a window crowded with goods, but it is surely a fallacy to suppose that it is necessary to make a window a catalogue, *i.e.*, to display one of every article in stock. The contents of a window should be composed of attractively arranged samples—it should not be a catalogue. The overcrowding of the show window is a fault common to the majority of windows with a small trim. The public passes a window like this year in and year out, scarcely turning to look at the congested display. In any case if lights *must* be included amongst the contents of the window they should at least be screened from the view of persons outside the window by suitable shades or translucent screens of low brightness.

One of the most striking sets of display windows I have seen are those of a well-known store in Oxford Street in the last few weeks. During the "White Sale" the windows were dressed in a tableau of predominant white figures on a dead-black background, very little lighting was used, but what was used was absolutely concealed and served to illuminate and get the exact effect necessary. In some instances small projectors were used with coloured glass fronts which projected the coloured light on to a particular object with very striking effect. I should think that the drawing effect of those windows was 95 per cent.; the other five per cent. did not stop because they could not get near the windows.

Another great advertising feature in an efficient window display is the advisability of leaving the lighting on after the closing of the premises. It is not necessary to employ people after closing hours, for the switching off, as the lighting can be controlled by an automatic "time switch" extinguishing the lights at a predetermined hour. In an average size window the current consumption per hour would not be more than one unit, which shows the value of this type of advertisement to be very great in comparison with the cost of lighting.

Factors Influencing Required Intensity of Illumination.

For show-window lighting no definite rules can be laid down as to the foot-candle intensity required, though it is obvious that the illumination for spectacular purposes will be generally in excess of that based solely on the revealing of outlines and nature of goods. A number of factors must be taken into account, such as the kind of goods displayed (dark goods require more light than light-coloured goods). The location of the shop is also an important consideration. If it is in the centre of the town surrounded by brightly lighted windows proportionally more lamps will be required to make the window stand out prominently than if in a side street or with comparatively dark surroundings. The size of the town will again have some bearing on the quantity of illumination required, for on the average the larger the town the higher the standard of illumination.

In consideration of the question of adequately lighting a window which may continually be altered from light goods to dark or medium, a great deal can be done with two or three alternative circuits. The complete scheme is made for the dark goods, when light goods are displayed alternate lamps may be switched off, which will still leave ample illumination for the effective display of goods of this nature. When such an arrangement is installed care must, however, be taken that reflectors are used which have a spread of light sufficient to cover the increased area, otherwise a patchy effect will be the result. In general units should be installed with efficient reflectors in a row, near the window glass at the top, which should be concealed from the view of the passer-by and spaced at a maximum distance apart not greater than

three feet. The illumination necessary may range from 10–30 foot-candles, depending upon the class and location of shop.

The energy consumption is best expressed in watts per *cubic* foot in view of the variety in the shape and dimensions of window-space, and average practice shows that extremely efficient results are obtained with installations consuming from 0·5 to 1·25 watts per cubic foot.

I have purposely refrained from discussing the merits of different forms and types of show-window reflectors, and I expect that the discussion will give ample information on this subject.

The Effect of Bright Lights adjacent to Windows.

While this introductory paper has been devoted primarily to show-windows, and various aspects of lighting as an aid to publicity will be dealt with by Mr. Leachman and others, a few words may be said on some aspects of exterior lighting which affect window-displays.

It has been remarked that the effect of a lighted window depends primarily on *contrast with* its surroundings.

It is evident that the effect of a charmingly dressed and skilfully lighted window may be masked by the exhibition of masses of very bright lights at a low level in its vicinity. Previous discussions before this Society have emphasised the objections to such lights on other grounds, for instance their tendency to dazzle the eyes of drivers of vehicles or pedestrians, thus acting as a menace to traffic. In view of the fact that the advertising value of a shop-frontage depends so greatly on the lighting in the vicinity it has been contended that a merchant who uses judiciously arranged concealed lighting ought not to be penalised by the glaring displays of his neighbours, some of whom (cinema halls, for example) may have no goods to display but rely on the exhibition of bright lights to attract custom. Again, large stores occupying a considerable frontage are sometimes induced to indulge in additional local street-lighting, along their row of shops.

Apart from its effect on their neighbours, it may well be doubted whether it is desirable, even in the interests of persons adopting such lighting, to indulge in glaring lights at a low level. In these days light in main thoroughfares is so relatively abundant, and the exhibition of glaring lights unfortunately still so common, that "attraction by glare" is of doubtful utility. It would be much better if lights supplementary to those used for illuminating the windows are adopted, to rely on tasteful and striking effect involving the use of decorative diffusing lanterns, the harmonious combinations of colours, and the concealing of lights behind diffusing screens carrying suitable mottoes or posters, etc., care being exercised to ensure that such devices assist and do not mask the lighting of windows. The use of light as an aid to publicity in this way deserves to be explored more fully. Really novel effects might be devised if the use of light to attract could be made an integral part of the design of large frontages of buildings. The diffused light embodied in such designs would be welcomed as an aid to regular street-lighting and would enhance the advertising value of a frontage without unduly interfering with the displays of neighbours.

The Lighting of Stalls at Exhibitions.

Finally, it may be remarked that the principles advocated for the lighting of shop windows apply generally to the illumination of stalls at exhibitions. A visitor to any of the large number of exhibitions recently held in London cannot fail to have been struck by the diversity of methods of lighting employed, and the very unequal values of lighting adopted. The opportunities for uniformity of treatment are obviously much greater than in a street where each shopkeeper is a law unto himself. Every exhibitor should have latitude to adopt special artistic methods of lighting according to his taste and the nature of the exhibit, but some general principles eliminating the indiscriminate use of bright unscreened lamps, with prejudice to the displays at neighbouring stalls, might well be imposed in the interests of the exhibitors.

The general spectacular lighting in exhibitions falls outside the scope of this paper, but it is generally recognised that in the past this has been subject to the same defects of want of scientific design and indiscriminate use of unscreened bright sources of light and that there is here a very promising field for the efforts of the illuminating engineer.

(B) ILLUMINATED SIGNS.

By E. C. LEACHMAN.

(Introduction to a discussion which took place at the meeting of the Society held at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C., at 8 p.m., on Thursday, February 24th, 1921.)

In considering light as an aid to publicity one is dealing with a subject which deserves much closer scientific study. In the United States illuminated advertisements are used on a large scale, but there is still little variety in the mode of application of the light. While illuminated signs occur to one chiefly as a medium of advertisement, their use in other fields of publicity has been steadily extending. On the railways, particularly the Tubes, their value for conveying information is now widely recognised. There is still much to be done in this field. It is singular that, although any place of business bears its name and description visible by day, and every private house its name or number, only in a few cases is any attempt made to illuminate such names, so that they " stand out " and are easily visible at night. Anyone who has faced the problem of tracing a house in an unfamiliar suburb by night will recognise the justice of the suggestion that the name or number should be adequately illuminated. The same applies to the names of streets. It is, of course, not so easy here to get access to a source of light, and in main thoroughfares the street-lamps are supposed to illuminate the name-plates. Actually, however, they are often difficult to distinguish after dark. If special local illumination cannot be provided, the position of the name-plate with regard to the nearest street-lamp, or the use of the glass panes in the lanterns of lamps at street-corners to indicate the names of streets (and possibly the numbers of a certain section to the next lamp), might be studied. Many public buildings, police and fire stations, post offices, etc., might be made more recognisable by some distinctive luminous device. Buildings of historic interest might also be so indicated—naturally with due regard to artistic effect and the avoidance of over-brilliant or glaring effects. London in the past has been a very cosmopolitan city, and in future will doubtless again be visited by foreigners in increasing numbers. Luminous signs could do much to aid them in their journeys through an unfamiliar city.

Properly conceived illuminated signs might prove a useful addition to public lighting. A great difficulty in street-lighting is the necessarily big distance apart of lamps, and the dark surfaces of city buildings which reflect little light. The darkness of the surroundings accentuates the apparent brilliance of the lamps, and the comparative absence of reflection leads to harsh shadows. Any light derived from show-windows, signs, etc., should therefore be welcome, provided it is diffused and does not consist of bright points of light. These facts are dwelt upon because hitherto the use of illuminated signs has revealed sharp differences of opinion on the part of advertisers and members of the public. In the future, such differences may become more acute, unless sign-lighting is studied in a scientific manner. Exception has been taken to the erection of very large and brilliant flashing signs in certain localities. While from the advertising standpoint such a sign has a legitimate purpose, it is undeniable that it may be disfiguring from the artistic standpoint. Discussion on this point is invited. It would seem possible, however, to meet the views of both advertisers and the public by some form of compromise. Most people are occupied by day but are more or less free to roam the streets by night. The appearance of a city by night is, therefore, a matter of consequence. Ability to recognise its streets and buildings depends mainly on provision of artificial light. How can this light best be provided so as to serve the purposes of publicity, and yet avoid offence? Some signs, it might be said, are so designed as to startle, rather than attract. But if signs can be designed on

truly attractive lines they would be welcomed by the public, instead of being accepted with reluctance.

The most familiar type of large sign is that constituted of letters outlined in coloured incandescent lamps, and worked either by thermo-flashers, clockwork, or electric motors, so as to give an " on and off " effect. Such signs inevitably attract attention, but it is possible that the startling effect, which may be compared with the beating of a drum every few minutes, may make more enemies than friends. Such rapid fluctuations in light may tend to prove distracting to drivers and pedestrians, so that the light acts as a danger to traffic rather than an assistance. The first flashing sign of this kind was erected about 1893 at the World's Fair. The expenditure involved may be very considerable. Thus an eight-foot letter takes, roughly, forty 20-watt lamps, and the current consumption and maintenance are both costly. In a sign erected in 1899 to welcome Admiral Dewey on his return after the war with Spain, 8,000 lamps were used.

Signs composed of masses of lamps require more careful design than is commonly supposed. In particular, the effect of distance needs consideration. Some signs are most effective at close quarters, others far away. The brightness of the lamps is another factor of importance. On the ground of economy one would naturally choose lamps of small consumption. At times rays of light from lamps are so strong as to intermingle, leaving insufficient dark space between letters so that one letter cannot be readily differentiated from another. The reading of the sign may become difficult unless viewed from directly in front—one merely gets the effect of a group of lights. This defect may be largely overcome by the use of trough-letters, rays of light being confined to each particular letter ; the advertisement can then be deciphered from almost any angle. Frosting of lamps has sometimes been practised, but such lamps rapidly become dirty. A white background behind the outline of a letter may help to promote continuity. The ten-watt lamp is commonly used, but the tendency is towards greater brightness, and the use of 20 or 25-watt lamps.

A sign in which the lamps are not all active or one in which a word is spelt out unevenly creates an unfavourable impression. Much care should, therefore, be devoted to maintenance. In some very fast-working signs a slight blur, like the tail of a comet, will be seen following each letter, owing to the fact that the light from filaments is not extinguished instantaneously when lamps are switched off. If a filament which attained full brilliancy quicker and cooled more rapidly could be obtained, the speed of such signs could be increased.

There is certainly room for a scientific study of the requisite size of letters to be seen at prescribed distances, and the desirable brightness of the points of light of which they are composed. The colour of lamps should also be studied. Some colours, apparently, tend to become blurred at a distance more readily than others. Generally warm colours, red and orange, are preferable to blue and green. The use of colour as a means of distinction is important. A comparatively small sign in red lamps, even of low candle-power, will stand out amongst adjacent white signs. Advertising with such signs would be much more effective if those using a crowded space would work on some co-ordinated basis. It is not unusual to come across two or three advertisements on a building, one advertiser using such large letters and powerful lamps as to drown the others—and yet not get a really satisfactory advertisement himself. The psychological effect attributed to colours should not be overlooked. Warm colours are associated with cheerfulness and a combination of harmonious colours —a well-executed colour-scheme is worth its weight in gold.

Before passing to other forms of signs I may refer to one special development of those based on outlining in lamps, namely, the moving pictures, in which a figure goes through a cycle of operations, owing to the appropriate lighting up and extinction of lamps by a suitable flasher. Such signs have reached their greatest development in the States. They naturally require a large space and to be viewed from a considerable distance.

The alternative to designs outlined in lamps is the pictorial advertisement, in which a picture is prepared in suitable

colours, and illuminated either from the front or by a source behind the picture, as a transparency. If well executed a pictorial advertisement is, in my opinion, invariably superior to letter-signs, and avoids the drawbacks of excessive brightness and glare referred to above. In the United States the use of " flood-lighting," *i.e.*, external illumination from projected beams of light, has been widely used for the illumination of large posters, and in this country it will, doubtless, become more familiar. Flood-lighting can yield very striking results, if the position is carefully selected. A comparatively dark background is needed, and in order to obtain uniform illumination it must be possible to mount the projectors a good distance away. In practice it is not always possible to find a suitable position for the projector. Posters and hoardings have sometimes been illuminated by lamps ranged along the top-edge and somewhat in front of the surface. The difficulty in such cases is to obtain reasonably uniform illumination from top to bottom, though special reflectors for this purpose have been designed. It is important that the actual sources of light, as in show-window lighting, should be screened from view of persons observing the illuminated poster.

Pictorial methods have the advantage that the user is free to select any desired subject, which should be tastefully designed. The huge coloured posters, badly executed and imperfectly lighted, to be seen outside some places of entertainment, serve as bad advertisements; they probably keep away as many people as they attract, since prospective customers are apt to judge the performance inside by the crudeness of the outside display. A well-executed and coloured portrait of a star artist or a good coloured picture representing some incident in a play not only catch the eyes of passers-by but rivet their attention.

The illuminated transparency advertisement sign is capable of very great extension and has the advantage of consuming much less current (in many cases about one-eighth) of that taken by a corresponding letter-sign. The cost of maintenance is also much less, while the effect is pleasing and lingers in the memory longer than a mere statement outlined in lamps. As compared with pictures illuminated from the front, one has the advantage of being able to secure greater contrasts between the light and dark portions of the picture, giving more " life." Naturally the spacing of lamps to secure even illumination is of considerable importance. Advertisers are coming to realise that 75 per cent. of the value of an advertisement is to be obtained after business hours, when work is over and people have leisure to walk the streets. Anyone walking the streets of a large city will be struck by the tendency of strolling people to congregate around restaurants, hotels, or places of entertainment—the only places where illuminated announcements are usually visible. The immense gain in advertising value of an advertisement with special provision for artificial illumination, as compared with one that only receives casual light from street lamps, or possibly none at all, is evident. Publicity agents ought surely to make more of a feature of the value of advertising signs after dark.

The value of show-window lighting as an advertisement is being dealt with by Captain Stroud. But I may point out that there is a great field for the use of such windows, not only for revealing goods sold but for the advertising of proprietary articles, and for railway, shipping announcements, etc. Such illuminated devices can be readily controlled by a clock switch, rendering it unnecessary for a person to be on the spot to turn off the light at a prescribed hour. The large shipping companies, and some industrial concerns, already make use of these devices.

The great difficulty in the past in producing artistic coloured transparencies has been the high initial cost. Unless one was producing about 500 pictures of the same kind the preparation work was too costly. This has now been overcome by the use of transparent paints on chemically-treated linen. A recently discovered process enables pictures to be photographed direct on the linen, so that even a small number can be produced at a reasonable price. The method gives improved richness of colour and high luminosity, and opens up a wide field for such devices. Important improvements in flashing mechanism have also been made. The " wireless " form used with

these signs is very easily replaced. It is only necessary to lift the flasher off its base and put another one in, no unwiring or re-wiring being needed. This enables the change to be effected by an unskilled workman, as well as saving much time in the process. The gradation of colour and tone attainable with such a transparency makes an ordinary illuminated sign appear flat in comparison. A feature is the low running costs and maintenance; generally speaking, these items are more important than the initial cost of a sign.

Apart from signs occupying a comparatively large space, such as those used for prominent advertising displays, there is room for special devices for small notices such as those largely used on the underground railways, as indicators in large Stores, etc. Naturally, outlining in lamps is rarely applied in such cases. Lamps should be invariably concealed from view. Where a large number of such signs are used economy in lamps is an important consideration. The box-sign is a simple device, but if it becomes at all large some skill is needed in order to get even illumination of the diffusing glass on which letters are stencilled without using too many lamps. In the case of very small signs various devices have been used in order to secure even illumination from a concealed lamp at one extremity of the sign; this again calls for ingenuity.

In the earlier portion of this paper I referred to the desirability of some co-ordinated system of dealing with lighting for advertisement. Judicious consideration to the size, type and location of signs would be for the benefit of the industry. Committees have been formed in many districts in the United States to deal with the matter, but their effect in some cases has been to discourage the industry rather than to control it. If, however, some form of concerted action could be arranged which, while using its influence to prevent the *misuse* of spectacular lighting, also encouraged its legitimate use, both as a medium for advertisement, and as a means of conveying information to the public, this would prove of great benefit.

In conclusion I may refer to one field, *i.e.*, in exhibitions, where this principle of co-operation could be easily applied. In most cases the chief impression one receives on entering an exhibition is, not the appearance of the exhibits, but a blaze of light—dazzling, bewildering and trying to the eyes. The lights are frequently so arranged as to make it impossible to ascertain where any particular stall is, or even in what part of the building. It would be an improvement if the exhibitions were divided into sections—an avenue outlined above with green luminous devices might represent stationery, office equipments, publishers, and advertisers—the next avenue outlined in red would represent machinery, and so on, every industry represented being outlined above with its own colour, and the stalls themselves illuminated from the inside by concealed lamps enabling the *visitors* to see the exhibits clearly, and in comfort. Regulations such as these would preclude the possibility of one exhibitor's lighting spoiling a neighbour's exhibit, which I noticed was the case in more than one instance at Olympia last week. Each stall should have its number clearly defined at the top of each corner in neat illuminated letters. The effect would be cheerful, artistic, and restful; one could immediately walk to the particular section one was interested in by noting the colour of the avenue light, and at once spot the number of the stall. After some hours one would be able to return home without that eye-strain, and tired feeling, so often experienced after visiting an exhibition and gazing helplessly about in a building with powerful overhead lights and a medley of stalls so arranged as to keep you guessing as to their object.

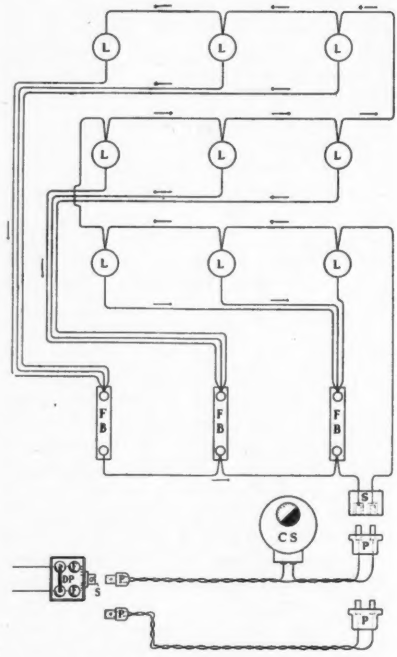
The lighting of all exhibitions should be conducted on a co-ordinated basis, with a view to studying the convenience and comfort of the visitors and the interests of the exhibitors. The present glare and jumble of lights is most confusing and disadvantageous. The lighting of the stalls should be so arranged that no glaring unscreened sources distract attention from the exhibits and the light is used in such a way that the eye is naturally drawn to the illuminated contents of the stall. Everyone would be the gainer, and under such a system no exhibitor could be a nuisance to his neighbour.

At the conclusion of his paper Mr. Leachman exhibited a variety of illuminated pictorial signs, explaining how each portion of the apparatus is standardised so that the whole can be readily taken apart or assembled.

The series of lamps is mounted in an enamelled iron frame with white interior, and operated by the special flashers in the manner shown. These lamps may have bulbs stained in various tints so that continually changing colour-effects are produced. Recently a method of surrounding lamps with tinted cylinders has been adopted, as in this way more delicate shades and combinations of colours can be used.

In front of the lamps is a light translucent sheet of glazed linen which acts as a diffuser, and again in front of this diffusing sheet there is the picture proper which is painted in special pigments on specially prepared linen. The colours are manufactured by the firm so as to give the desired transparency; a remarkable feature being that by daylight, illuminated from the front, the picture appears to be executed in opaque colours so as to resemble an ordinary painting, whereas by transmitted artificial light they are highly translucent, giving a vivid luminous effect. Pictures are hand-painted, but coloured portraits of actors, cinema stars, etc., are first reproduced photographically to give the requisite outline and tone, and then painted.

In this way many reproductions of the same picture can be easily obtained, and such pictures are rented to cinema theatres, etc. Pictures are of standard size and roll up for fitting into standard metal cylindrical cases. In the extreme front of the sign is a glass sheet, readily detachable. If necessary, lettering, indicating the nature of the performance, can be rendered on this outer glass, so as to appear black against the brightly illuminated background by night. Owing to the manner in which every component part is standardised it is possible to substitute a new picture in a few minutes. A feature is the special "wireless" flasher which can be inserted between metal contacts in the same manner as the ordinary type of bridge-fuse, the intermittent action being produced by the expansion of a metal cylinder



Plan of Wiring Arrangements.

L L, Lamps; F B, Flasher Base; S, Socket; P, Plug; C S, Clock Switch; D P, Double Pale Switch; F, Fuse.

surrounded by a coil of fine wire. On expansion the edge of the metal cylinder comes in contact with an adjustable metal point, short-circuiting the coil, after which the process repeats itself.

Mr. Leachman explained that one object of the signs was to provide a more pleasing pictorial device for use outside places of entertainment, and later on for educational purposes. Illuminated pictures of this kind could, however, be used for many purposes. If desired, a clock switch could be inserted in the wiring circuit automatically extinguishing the sign after a pre-determined period.

A number of different pictures were shown in succession, attention being drawn to the high luminosity and vivid colouring and the variety of subjects. Mr. Leachman also showed how the usual frame and lamp arrangements could be applied to an adjustable letter-sign, suitable for indicating the nature of performances. All that is done in this

case is to replace the picture and outer glass sheet by a black-enamelled metal frame, in which letters (comprising enamelled metal plates, with letters cut out and backed by translucent linen) can be inserted at any desired intervals. Complete sets of letters are provided in boxes of standard design. In this case also, the use of flashers and coloured lamps serves to attract attention, but the letters remain luminous throughout the colour-changes. The device has thus both the advantages of the ordinary box-type of direction sign, and of intermittent flashing signs in which lettering is interrupted.

(*DISCUSSION.*)

Mr. E. T. RUTHVEN MURRAY exhibited a type of sign which utilised total internal reflection inside a plate of glass. The light was provided by concealed tubular lamps at the top (and if necessary also at the bottom) of the sign, on the back of which letters or devices were etched. These letters appeared brilliantly illuminated with the transparent glass surrounding them. They were also clearly visible by day, without the artificial light being switched on. Any form of lettering that the advertiser desired could be used. Thus one of the signs exhibited bore the words "Publicity Pays" in white letters. In another case an advertisement of "Pears' Golden Series" reproduced in their well-known special script; the letter appeared gilt by day and a golden colour by night. The candlepower of the lamps could be adjusted according to the degree of illumination prevailing, but, as would be seen, the actual brilliancy of the letters was such as to cause them to stand out even in a strongly-lighted room.

Mr. E. T. RUTHVEN MURRAY said he was glad that Captain Stroud had emphasised the importance of shielding gas-filled lamps used in show-windows. He agreed that in many cases shopkeepers crowded too many articles into their windows, which should not be expected to form a catalogue of the merchant's stock. It was, however, satisfactory to find in how many instances, both in London and in the provinces, leading storekeepers now employed concealed lighting in quite the approved and most attractive manner.

It was worth noting in how many cases colour was of great value in attracting attention. He had remarked this particularly in connection with the exhibit of the Sheringham Daylight at the recent exhibition at Olympia, where the appearance of coloured objects by this light and by an ordinary gas-filled lamp were exhibited side by side.

In his most interesting paper Mr. Leachman had referred mainly to sky-signs and pictorial advertisements. There were, of course, many opportunities for the use of other forms of signs, of which the Underground Railways' directional signs furnished many excellent examples. The public were becoming accustomed to receiving instruction and directions in this form, indeed, they seemed to like it; and he was surprised that a greater use of direction-signs was not made in the large stores. The use of these smaller signs was extending more rapidly than the larger sky-signs, and it was evident that there was far greater opportunity for developments in this field. Such signs, however, called for careful design. It was not easy to get artistic, attractive results, especially with suitable colour-combinations. Another point of importance was that, in order to be widely used, a sign should be adjustable to varied conditions—for example, it should enable any special forms of script such as were a recognised element in the advertisements of many large firms, to be faithfully reproduced. He thought the "Internalite" signs, of which examples were shown, might with truth be termed a sign of distinctive design.

Mr. J. W. FIELD (Brilliant Sign Co., Ltd.) exhibited two forms of illuminated signs which had interesting features. The first was a box sign, suitable for mounting on a vertical wall or shop pilaster as illustrated in Fig. 1, which was illuminated entirely by means of a single lamp mounted in the small metal cowl at the top. The two sides and one end of the

sign could all be made of translucent material and used for advertising purposes. The box was of metal with a whitened inner surface so as to assist in diffusing the lighting and getting even illumination.

Fig. 1.—Typical box sign, illuminated by a single lamp at top, readable on both sides and one end if required.

The lettering and designs were executed on the back of the glass in any desired colours, reproduced and made durable by "Koparine" transfers. Provision was made for ventilation and access to the sign was facilitated by a door at the bottom. Flat signs, also readable on both sides, for use in daylight and capable of suspension from a light bracket were also made in great variety. The discussion had turned largely on signs illuminated by artificial light, but it should be remembered that the great majority of signs used by the public were intended primarily for use in daylight. The Company had a great deal to do with such signs, some of which also were of interest to the lighting engineer. He might mention, for example, the signs utilising letters, outlined in small silvered spheres, which focused the light falling on them and became bright points when illuminated by daylight, and also "stood out" well if the available artificial light from street lamps in the vicinity was fairly high. The signs alluded to above were mainly used for stationary effects, though they could, of course, be used with flashers if desired.

The second sign exhibited, the "Kaleidosign," made use of a moving device. The outer annulus of the face was devoted to the subject of advertisement, but the inner area was occupied by a kaleidoscopic effect. The light from the lamp at the back of the sign passed through a cluster of loose pieces of coloured glass between inclined mirrors, which was focused on to the ground glass disc, forming the front of the sign, by a suitable lens. An electro-magnetic device in the lighting circuit was devised to jerk the pieces of glass at regular intervals, thus continually altering the kaleidoscopic pattern focused on the central portion of the glass front. This changing pattern attracted the attention of passers-by, who could not fail also to notice the surrounding advertising matter. An idea of the appearance of the sign would be gathered from Fig. 2.

Fig. 2.—Showing typical appearance of "kaleidosign."

It was remarked that window-dressing and window-lighting should be considered together. It was also often advantageous for shop-lighting, and the use of illuminated signs, to be undertaken jointly with the design and provision of shop-fittings. The Brilliant Sign Co., Ltd., was amalgamated with Stanley Jones & Co., Ltd., who had much to do with the equipment of shops, and in some cases they, in conjunction, provided the entire window fittings (enclosures, glass shelving, etc.) and carried out the lighting installation. In other cases, however, firms had their own electrical engineers, and the arrangement of the lighting was undertaken by them.

Mr. A. W. BEUTTELL said the sign he showed was the result of an attempt on

the lines indicated in one of the papers to do the lighting of a box sign from one side only, and to obtain a uniformly illuminated field all over the box. There was no diffusing screen. The letters could be transparent glass. One looked through transparent glass at an illuminated background. The white centres of the letters were for giving a daylight effect when the sign was not alight. In that sign there were only lamps at the bottom. If one lighted top and bottom an area of 4 ft. to 6 ft. could be reached without any break in the middle, whilst maintaining uniform brightness.

Mr. Beuttell added that no doubt they were all impressed by the facts that for every show window reasonably illuminated there were a dozen that were not, and that for every shop that had an illuminated sign or facia a hundred had not. There was room for propaganda work which could possibly be undertaken by that Society. A Committee of the Society could co-operate in this matter with the societies associated with the various trades concerned, and educate the consumer as to the importance of the subject. Such propaganda would of course press the point that good lighting was good advertising. With regard to exhibitions the matter would be simple, as the Committee would approach the governing body of the exhibition, and advertising agents of firms would also have their own associations which could be dealt with. With regard to getting black letters on a uniformly illuminated white background, it could be done and was fairly effective, and it also provided a useful background for showing illuminated posters. He had got an exceedingly good effect by putting ordinary dramatic posters between two sheets of glass and showing them in that way.

Mr. J. C. Elvy said that a sign should not only be capable of attracting persons in immediate vicinity, but also persons from a distance, say, the opposite side of a street, and, further, of retaining those persons sufficiently long enough to attract others.

Recently his own attention had been drawn to such a sign, two samples of which (the " Aurolite " sign) were being exhibited at the meeting by Mr. White. One sign was of the picture frame, frosted glass, window type, and the other a frosted glass sphere.

The simplicity of this novelty especially appealed to him, the moving part being a mica sheet cylinder, on which transparent colours were painted, the cylinder enclosing a 100 watt gas-filled lamp, the heat from which caused cylinder to rotate in one direction about its centre by means of a wind-vane at the top end of cylinder. A dual purpose was thus served by the lamp which produced a moving coloured cloud effect on the frosted glass; the sphere type of sign had the appearance of a rotating large-coloured ball of light. In the earlier type the bearing in centre of wind vane was what appeared to be the bottom of a glass test tube, which ran on a pointed wire, the latter being supported by coiling it around lamp-bulb. A later and improved bearing would be observed in the two exhibits where an agate centre and a gramophone needle were employed.

The cost of upkeep was very small, there being very little to go wrong—no clockwork to fail, for instance; it should therefore appeal to those whose requirements in this direction would not admit heavy expenditure or elaborate ideas. After all, a sign merely had to perform the function of attracting attention.

From an advertising point of view, one must bear in mind the desirability of occasionally substituting a sign which embodied entirely new attractions, so soon as the public curiosity in the original type appeared to have been satisfied. This meant that there is quite a large field to be exploited by sign manufacturers. These remarks of course did not apply to all classes of signs, *e.g.*, Mr. Ruthven Murray's exhibits he should regard as somewhat of a permanent nature, being a distinct departure from the glaring spectacular type.

In the discussion views had been invited on the best colour for illuminated lettering of railway destination, etc., boards. He (Mr. Elvy) was of the opinion that yellow on black was certainly to be preferred to the " glaring " white frosted type on black. Some care had to be exercised in the spacing of letters to render them clearly readable at some distance away.

The more elaborate picture signs show considerable enterprise on the part of the makers, and a wide field of service should be available for signs of this description. The authors had performed a real service to the publicity world by introducing this subject to the Society.

Regarding flashing devices of the thermal type, there has been a difficulty in obtaining a really good reliable instrument that would perform its functions accurately. He doubted even yet whether a satisfactory one had been evolved. If it had, he would like to hear of it.

With regard to shop window display lighting, where coloured fabrics, etc., were concerned, Mr. Ruthven Murray had referred to the Sheringham "Daylight" Reflector Device. Mr. Elvy would also like to draw attention to the panels of special glass exhibited by Messrs. Chance Bros., of Birmingham, at the *Daily Mail* Efficiency Exhibition, and which the makers claim achieves the same object when interposed between illuminants and fabrics, etc. It might naturally be assumed that the composition of the glass would have to be varied to suit various types of illuminants.

The CHAIRMAN (Mr. Justus Eck) said that they greatly regretted the absence of Mr. Sydney Walton, who had consented to preside over the discussion, but was unfortunately prevented from doing so by indisposition. Mr. Walton's very successful work in connection with the Government publicity schemes that had been carried out during recent years was well known, and they would very much have liked to have heard his views on the subject of the discussion.

Among others present, at the meeting were Professor Sano and Commander Kido, from Japan, where illuminating engineering had been making rapid progress recently. It was also a pleasure to welcome to the meeting Lady Parsons, the President of the Women's Engineering Society. They all recognised that in many fields of illuminating engineering, particularly in regard to the lighting of the home, women could render valuable services.

Proceeding, the Chairman remarked that he had been much struck by the feeling of good citizenship expressed in the introductory papers. Both Captain Stroud and Mr. Leachman wanted everyone to be fairly treated, and to strike a balance between advertising effort and the comfort of the public. Exhibitions, he thought, presented a particularly favourable field for co-operative effort. It would invariably be found that the common good was also most beneficial to the individual, however self-seeking he might be.

He appreciated the great field for artistic and creative effort in advertising and publicity through the use of light, but in these times it was essential that the claims of economy, especially as regards the costs of maintenance, should be attended to. He was glad to see that this point had been emphasised in both the introductory papers.

Mr. H. SEAL (Display Manager to Mr. Selfridge) expressed his agreement with the remarks in the paper with regard to window lighting. He felt that there was a great deal to be done in this direction, particularly as regards the use of projected light, which had been studied only to a very small extent. There was also something to be said for foot-lighting of windows as well as the customary method of arranging lighting along the top of the window. Electric signs were a little out of his line, but he thought that efforts should be made towards securing a more dignified and refined effect which would doubtless extend their applications.

The Honble. LADY PARSONS (Chairman of the Women's Engineering Society) briefly expressed her pleasure in attending the meeting and witnessing such interesting exhibits. There were many aspects of lighting that were of special interest to women, particularly those in which the choice of colour and artistic design were involved. If executed in a tasteful way luminous signs added greatly to the pleasure of journeying in a city by night. A debt of gratitude was due to lighting experts who had done so much to render the streets of London cheerful and brightly lighted by night. The impression that they created did much to dispel the gloom associated with the war, and many of the illuminated signs now displayed were delightful to witness. It was the essence

of good advertising to convey an invitation to use a certain article in a pleasing way. The applications of light were intimately associated with art, and it was to be observed that in many of the pictures now on view at exhibitions searchlights and other luminous effects formed an important feature. Artists should accordingly be grateful to illuminating engineers for providing them with a new *motif*.

Mr. S. G. ELLIOT: By the courtesy of Mr. Cooper (Chief Engineer Underground Railways), it is possible to give a few particulars of the development of sign lighting on the Underground Railways. The aim is to obtain a well-lighted sign with as few lamps as possible, and the following photographs show examples. Fig. 1 is a sign on the platform at Piccadilly Circus, measuring 4 ft. by 2 ft. by 7 in.; it originally contained eight 30-watt lamps, but now contains only three 30-watt tubular lamps; the saving is therefore considerable and the illumination quite good. Fig. 2 shows a sign in Jermyn Street fixed on the Piccadilly Circus Station front; it measures 8 ft. by 2 ft. 9 in. by 6 in., and originally contained twenty 30-watt lamps; it is now well lighted by eight 30-watt tubular lamps, so that the saving is again considerable.

The above signs are lighted on the "Beuttell" system, the principal features of which are: (1) All lamps are concealed so there is no "spot" lighting effect, and consequently maximum legibility of the notice is obtained; (2) the small number of lamps necessary for adequate lighting.

Fig. 3 is an example of flood lighting, a system used extensively in the United States, but for which apparently no one in this country has specially catered. The sign is of enamelled iron and fixed at Sloane Square Station; it measures 22 ft. by 11 ft., and is lighted by a B.T.H. projector, containing one 500-watt gas-filled lamp, placed at 25 ft. distance and concealed. This sign replaced a glass box sign containing thirty 60-watt lamps. There are certainly many opportunities for sign illumination by flood lighting in this country, but the sites should be carefully chosen with a view to concealing the projector wherever possible. Many sign manufacturers do not, in my opinion, give sufficient attention to the efficient lighting of glass box signs, and in consequence unnecessarily high running costs are incurred. A new design of sign made

Fig. 1.—Showing indicator sign on platform at Piccadilly Circus Underground Station.

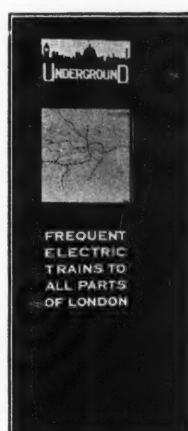


Fig. 2.—Showing sign in Jermyn Street (Piccadilly), with illuminated map.

by Messrs. Vergne was recently seen, which required only one lamp to light a large box sign from the interior, and the result was quite good.

I should like here to express my thanks to Mr. Dow for taking the above photo-

Fig. 3.—Showing illumination of name at Sloane Square Station by flood-lighting projector.

graphs; he spent quite a lot of time one evening on this work, also Mr. Every, Signal Engineer Underground Railways, for permission to use them and add the above notes.

I desire to associate myself with the remarks of the authors of the two papers regarding the need for concealing or obscuring the bare filament of gas-filled lamps from persons' eyes. Deplorable lighting effects with bare lamps of this type in shop windows can be seen everywhere, and the thought occurred to me how desirable it would be, if it were possible, to prohibit the sale of these lamps except to persons who could produce a certificate from the Illuminating Engineering Society showing they know how to instal them to the best advantage! A well-lighted window with properly concealed lamps undoubtedly encourages trade, whereas the effect of a bare gas-filled or other brilliant light hanging at eye level in a shop window, often without any shade or reflector—a state of things very often seen—has the opposite effect.

Mr. A. Cunnington (L. & S.W. Railway) said he could not claim to deal with signs as an aid to publicity, except in one special direction. On a surface railway illuminated signs were not much used except perhaps at large terminal stations. The lighting of the station name, however, was an important matter which he thought might be dealt with by means of illuminated signs. Hitherto it had been the custom to write the name of the station on the outside case of a lamp, which was not a desirable arrangement. It was liable to be missed by passengers, and one did not want people to pass beyond the station they wanted. He had been experimenting with a type of sign which might be of some value. He wanted, first of all, one which could be placed transversely on the platform so that anyone looking out of a train would probably see it, and even if passed it might be seen by looking back along the platform. A sign placed longitudinally on the platform could only be seen from about opposite.

He was encouraged to go on with his experiments by a sign which had only recently been put on the market and about which Mr. Vergne might have something to say. It was lighted by a single lamp at the extreme end of the sign, and should be very useful where the sign projected in bracket form from a wall. That was what he wanted for station purposes, and it would also be useful for projecting from shops. It met the point in regard to economy raised by Mr. Elliott, who needed to work a large number of signs with small current consumption and a small number of lamps. If one could work each sign with one lamp only it would be very economical in maintenance.

He was also interested in the question whether white on black or black on white was best for distant view. The particular application to signal work which he had in mind was hardly relevant to the papers, but he thought the matter of general interest where illuminated words must be seen at a distance. The modern tendency was to favour white on black, but he found under certain conditions of low illumination a black sign on a white illuminated background showed up more clearly. Of course, it was easier to obtain uniform illumination with a black background, as irregularities would not show to the same extent.

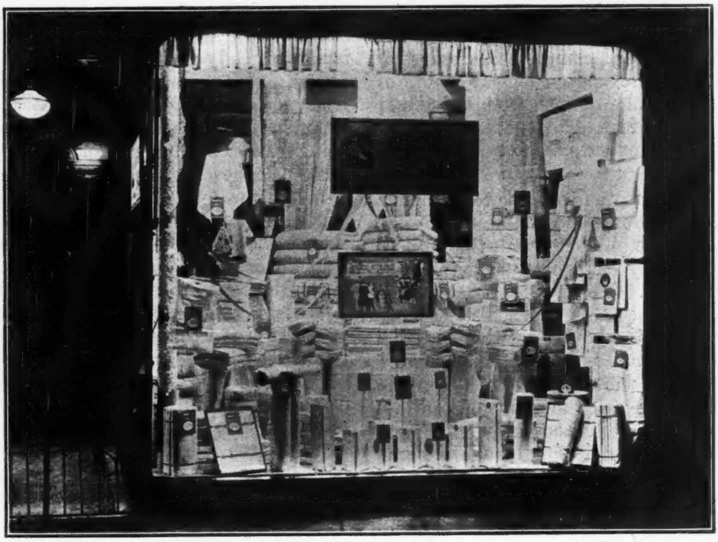
Mr. L. M. Tye emphasised the importance of selecting the correct types of reflectors for any specific show-window lighting problem. Consideration had to be given to the heights of the windows and also the depth which had to be covered. Many charts are now available

which render material help in this direction.

Mr. Tye also exhibited a number of slides showing the satisfactory results which had been obtained by the use of the Holophane special angled reflectors which have been especially designed for concealed window lighting. In a number of these examples the foot-candle intensity recorded was in the order of 25 foot-candles, and attention was drawn to the particular absence of "flatness" in the results.

Mr. W. G. RAFFÉ (Art Director, Northern Polytechnic Institute) said that could not be used in situations where a tasteful and not unduly obtrusive effect was necessary. Some leading firms had shown a recognition of the value of the services of artists in the colour and lighting field. He himself had given a course of lectures on "Colour and Display" at Selfridge's, with good results, also at the City of London College.

Apart from the use of signs for specific advertising purposes they could be used with advantage for the purposes of giving directions, for indicating names of streets, etc. In main thoroughfares, provincial and metropolitan, direction signs



An attractively lighted "White Sale" display, Messrs. Hatcher's, Taunton (Mr. L. M. Tye).

signs exhibited had been most interesting and many of them artistic. In particular, he was struck by the attempts made to utilise colour combinations. Monotony of colouring interfered much with the effectiveness of certain forms of signs. Ideal conditions of illuminating publicity could only be obtained by the combined efforts of the artist and the lighting expert. At present he thought that artistic considerations did not receive sufficient attention, with the result that many forms of signs, while doubtless partly effective as advertising devices, giving the points of the compass would often be useful to strangers. When such signs were attached to street lamps care should be exercised to prevent undue interference with the primary object of the lamp—the lighting of the street. He noticed that in Hampstead posters advertising Building Loan had been affixed to lanterns, whereby the illumination in certain directions was reduced.

The choice of good lettering for signs had a great deal to do with artistic appearance, and he liked the forms used

in some of the signs exhibited at the meeting.

The value of window transparencies for store windows is seldom realised. They effectually screen half-watt lights while using the light to note good colour, if not the advertisers' announcement as well. In fact, the whole question of stores' windows and departments generally needs expert advice on colour arrangement.

He thought that if churches and chapels were better and more effectually lighted they would attract more people. They needed signs outside and properly shaded lights inside.

A motor-bus at night is a moving illuminated sign, but the best effects are seldom realised, out of the excellent possibilities of locomotive varieties of publicity. The psychological side of light and colour both demands and deserves a great deal more study by illuminating experts.*

Mr. L. GASTER moved a vote of thanks to the lecturers and exhibitors. The attitude of the public towards this subject had competely changed during the past twelve years. He recalled that about twelve years ago he was asked to contribute an article on shop-window lighting to a journal devoted to drapery and clothing, in the course of which he advocated concealed methods of lighting. Correspondence subsequently appeared in that journal criticising his views, some representatives of leading stores objecting to the idea that lamps should be concealed from view, as he then proposed. To-day these stores, in common with other leading establishments in their respective trades, had adopted concealed lighting. It was interesting to note that the regulations affecting the lighting of shop-windows during the war also tended in the same direction, the exposure of unscreened lamps being prohibited, and instructions given for methods of diffused lighting to be employed.

Mr. Gaster pointed out that when a man's windows were deprived of adequate daylight through the erection of a neighbouring building he had a remedy under law if he could prove "ancient lights." It was a question whether, if a window-display was similarly prejudiced by the use of extravagant glaring lights on the part of a neighbour, the owner might not also be entitled to compensation.

Mr. A. A. VERGNE (*communicated*): I have pleasure in giving some further particulars of my illuminated sign, to which reference was made at the meeting. The sign is enclosed in a wedge-shaped case of sheet metal, enamelled in a non-corrosive block. At one end of the sign, where the wedge is thinnest, is fitted a box containing a lamp in a concentrating reflector, the box being hinged so as to facilitate ready access for cleaning. The actual design or inscription is marked in Koparine on heavy plain glass, backed by a transparent flashed opal glass, the whole being fitted into the case and finished off with oak beading.

A single ordinary standard lamp suffices to light the entire surface of the sign. The light is projected along the whole length of the case by the reflector, both sides of the sign being evenly lighted. The reflector utilises a surface of electro-silvered brass, and has a high reflecting power.

The device is specially applicable to name-plates in railway stations, notices or direction-signs. With a single lamp a length up to four feet can be lighted on both sides and the illumination is remarkably even, without the patches that are ordinarily apt to appear when attempts are made to illuminate a surface by a source at one extremity. One unit of electricity suffices to illuminate twelve square feet of surface for a period of about 18 hours.

Mr. J. H. ASDELL (*communicated*): Although considerable emphasis has been laid upon glare in shop windows, I doubt whether it is fully appreciated that an exposed lamp in the line of vision may cause a diminution of more than 90 per cent. in effective vision, so that it becomes extremely important from the point of view of all-round efficiency to shield the lamps from the eyes.

It has been mentioned that it is the duty of the illuminating engineer to

* A small but interesting volume on "Colour and Health" contains some important information on colour psychology. It is published by the College of Chromatics at 3, Finsbury Square, E.C. 2, price 5/- net, 5/4 by post.

educate the shopkeeper to the fact that he should adopt the open type of dressing for his show windows. This is very much open to question, for after all the shopkeeper is out to sell his goods and not to make pretty pictures. A short time ago, in the course of a conversation with a Manager of a very large, high-class Stores in North Britain, the style of window dressing was discussed, and the Store Manager pointed out that when he adopted the open type of dressing, as adopted by the majority of shops carrying on the same class of business in the United States, his sales fell off by about 40 per cent. So that it would appear that the general public themselves are in need of the education in the first place. One cannot expect a shopkeeper to bear considerable loss over an extended period while his public are being educated, unless he is going to see very considerably increased returns at a later date.

There are well-known shops in London where a very close dressing is adopted, the shopkeeper having studied the psychology of his customers, and in such cases illumination from troughs or reflectors at the top of the window is not possible; it is suggested that in such cases the best method is the application of a miniature form of trough reflector with tubular lamps, which can be placed underneath shelves and is quite unobtrusive. In cases where dressing is made right up to the glass it is only possible to provide illumination by the installation of angle lanterns placed outside the shop.

As regards illuminated signs, Mr. Leachman has suggested that information is required regarding visibility. The following rule will be found useful in this respect. Size of letters in inches multiplied by 40 equals visibility distance in feet. This formula is based on the visibility of the letter "S"; the least visible letter is the letter "A," which has only 75 visibility assuming the visibility of "S" to be 100, but usually one does not read each letter separately but the sign as a whole. Legibility of the letter "S" may be taken as the indication of the legibility of the sign.

Emphasis has been given to the success of pictorial displays so far as advertising is concerned, but if one is to judge by published results a "Slogan Sign" is probably the most efficient. Some of the most successful advertisements of the present day contain no picture, but merely wording. It would appear that if one can keep people guessing as to what is coming next, the success of an advertising medium is assured, so that curiosity becomes the keynote of ultra publicity.

Mr. S. Brook (*communicated*): The need for notifications, legible at night, must be realised by all who have to visit new places and neighbourhoods. Street names cannot be found, house numbers are illegible, bell pushes cannot be seen.

Also in the house, switches, gas taps, bottles, telephones, corners, staircase commencements, etc., all need advertisement, but the complication and cost of illuminating these by electricity, gas or oil is prohibitive in conception, although possibly not in fact if all lost time and broken articles were taken into account.

The solution of this difficulty is the using of radium salts, in combination with zinc sulphide, etc., by means of which a continued luminescence for long periods is obtained at no cost after the first initial outlay. These devices, known by the name of "Perpetulo," require no sunlight to energise them like the well-known Balmain paint, but continue to give their light for years even if kept in continued darkness, and directly the eye has got its night-vision may be seen at quite long distances; for instance, a three-eighth inch diameter Perpetulo Button is visible at 12 ft., and a door or gate number at 16 to 20 ft., according to size, while an Exit sign of 6-inch letters would be visible at all requisite distances in the event of the interruption of the gas or electric supply in a place of public entertainment.

Although the cost of radium is, if measured by weight, enormous, yet used with the necessary technical and chemical knowledge a very little goes a very long way.

Country sign-posts, radium painted, would be a boon in windy weather, even luminous information as to the next collection at a rural letter box would be very useful, while the legibility of names given to country cottages would be a boon, and all could be achieved without running costs.

TOPICAL AND INDUSTRIAL SECTION.

[The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona-fide* information relating thereto.]

SEMI-INDIRECT GAS LIGHTING.

Through the courtesy of the Bland Light Syndicate, Ltd., we reproduce herewith a view of an installation carried out by this firm at the Dartmouth Hotel, Catford, We are informed that the three pendants used were fitted with 20 in. opaline bowls, each equipped with four Bland "A" type burners, rated to give approximately 100 candles per burner, with a consumption of 3·75 cubic feet of gas per hour.

This is an interesting example of semi-indirect lighting, showing how the methods now becoming popular in electric lighting can also be realised with gas. We understand, also, that the room burners are provided with pneumatic switches, enabling the lights to be turned on automatically from a distance, thus carrying still further the resemblance to electrical devices.

We are informed that the same methods are employed in other parts of the building.

NEON GAS ELECTRIC SIGNS.

We understand that the Hewittic Electric Company, Ltd., of 80, York Road, King's Cross, London, N.1, are now introducing to the English market the "Neon" Gas Sign, which is extensively used in Paris. "Neon" Gas, it may be recalled, was discovered in 1896 by Sir William Ramsay and is present liquid air apparatus invented by Mr. George Claude, to whom the idea of using this gas for making light is also due. After a prolonged series of researches, Mr. Claude introduced the first type of lamp which was made up of a long glass tube of nearly two inches diameter and about 16 feet long, provided at each end with two large metal cylinder electrodes.

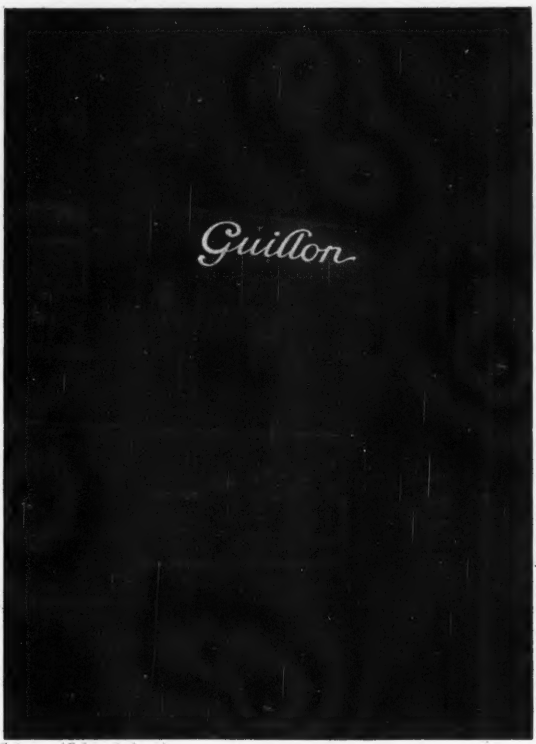


Fig. 1.—Name outlined in Neon gas tube.

in air in the proportion of one part in 66,000. "Neon" is distinguished from other gases by the remarkable facility with which it passes an electric discharge, the space between the electrodes being filled with a vivid yellow-orange coloured light.

The production of "Neon" in industrial quantities has been facilitated by the

Eventually a type of tube was developed which is considered extremely suitable for making up luminous signs, this tube being about half inch diameter and shaped to suit the various letters. All types of letters can be made, but at the present time, owing to the heavy demands made upon the factory, it is only possible to supply block letters

Fig. 2.—Another example of the use of Neon gas electric signs in Paris.

which are made in two standard sizes, namely 16 in. and 10 in. high. These letters are connected in parallel to a transformer where the supply is alternating current, or to a Ruhmkorff Coil in the case of direct current. The current consumption is stated to reach only roughly about two watts per letter. The striking orange colour of the light is favourable to the use of these tubes for advertising and spectacular lighting. These tubes need no attention, and are stated to have a remarkably long life.

It has also been stated that the colour of the light is favourable to distinct appearance when viewed from a distance, and that Neon lamps may therefore find special applications as luminous signals.

Fig. 1 and Fig. 2 show some of the many "Neon" Tube signs now in operation in Paris. The script sign in Fig. 1 has been in operation since before the War, the block letter signs at each side having been added lately.

The first cost of the sign is comparatively low, and the Hewittic Electric Company are making preparations to instal a number of these signs for the commencement of the next lighting season.

NEW LIST OF OSRAM (G.E.C.) LAMPS.

A new and complete list of Osram, Osram gas-filled and Robertson (carbon filament) lamps has been issued by the General Electric Co., Ltd. A short introduction giving a summary of developments at the Osram-G.E.C. lamp works is provided, after which full particulars of various types of lamps. Diagrammatic sketches showing dimensions and position of filament in the bulb are given. The booklet is completed by a note on illuminating engineering illustrated by photographs of lighting installations.

"DORICLITE" FITTINGS.

An interesting form of semi-indirect lighting unit ("Doriclite") is announced by the General Electric Co., Ltd. The unit consists in two parts, a bowl underneath and a reflector of larger diameter above, both made of Equilixo diffusing glasses. The filament is thus screened from view and the fitting has the advantage that it can be used in places where the low-reflecting power of the ceiling makes it inadvisable to use open bowls.

INDEX, March, 1921.

REVIEWS OF BOOKS AND PUBLICATIONS RECEIVED.

Elements of Illuminating Engineering. By A. P. Trotter. (Sir Isaac Pitman and Sons, Ltd., London, 1921. 103 *pp.,* 63 *illus.* 2*s.* 6*d. net.*)

MR. TROTTER's work on "Illumination, its Distribution and Measurement," will be familiar to our readers. In the booklet now issued under the above title he presents a brief summary of the chief principles of illuminating engineering, which should form a useful supplement to the "rule of thumb" so often followed in lighting. The first chapter deals with laws and definitions. Following this attention is devoted to vision and glare, the eye being very properly selected as coming next in importance. Mr. Trotter then deals with the chief illuminants, illustrating the methods in which light is distributed from each, and gives some useful hints on shades and reflectors. Next we have a chapter on photometry and finally some advice on the planning of lighting installations. Mr. Trotter has contrived to give a considerable amount of useful information within a small compass. We can recommend this booklet to those anxious to gain an insight into the fundamental principles of illuminating engineering. Fuller information can be obtained from Mr. Trotter's earlier work, referred to above, and from other sources which he mentions in his introduction.

The Electrical Lamp Industry. By G. A. Percival. (Sir Isaac Pitman and Sons, Ltd., 1920. 112 *pp.* 3*s. net.*)

MR. PERCIVAL's work forms an addition to the "Common Commodities and Industries" series issued by Sir Isaac Pitman and Sons, Ltd., which aim at supplying information on standard industries in a popular form. Much of the present work is devoted to a description of the making of electric incandescent

lamps, but some particulars of arc lamps and vapour lamps are also given. The author provides a short historical introduction. The contents of the book are easy to follow, and we think it should prove interesting even to non-technical readers. We are inclined to think, however, that if, without undue expansion of space, a little more could be said in the next edition regarding the importance of the lamp industry to the country, and some illustrations given of the value of good lighting in the interests of health, safety and efficiency, this would greatly add to its attractiveness.

The Kinema Operator's Handbook. By W. S. Ibbetson. (E. and F. N. Spon, Ltd., London, 1921. 160 *pp.*, 37 *illus.* 4*s.* 6*d. net.*)

In view of the interest that has been taken in recent discussions before the Illuminating Engineering Society on kinema problems, the appearance of this little guide is welcome. Mr. Ibbetson lays stress on the importance of the operator being familiar with the processes underlying successful kinema work, besides the more strictly technical aspects of his work. Modern kinema projection, he truly remarks, cannot be done by a boy who merely turns a handle. The author accordingly seeks to give a broad survey of the subject. After an introductory chapter explanations of the optical system and the projector mechanism are given. Some simple electrical engineering information, including hints on fuses and switches, and the care of generators, etc., are next given. The maintenance of apparatus, cleaning and repairing films, fire precautions, etc., is dealt with and finally there is a chapter describing standard and new forms of projectors. The kinema operator who diligently studies this handbook will gain much useful knowledge, and others associated with the kinema industry might also benefit from its perusal. The hints on the conditions governing size of picture and illumination, length of throw, etc., are useful. The author makes it clear that the illumination on the screen is inversely proportional to the area of the picture, and that, assuming this is the same, length of throw should not affect the brightness—except in so far as there is apt to be more or less absorption of light by the smoky atmosphere.

The Practical Electrician's Pocket Book, edited by H. T. Crewe. (S. Rentell and Co., Ltd., London. 1921. *pp.* 522 + lxxii. 3*s. net.*)

The twenty-third edition of this well-known pocket book, which is now included in the list of books recommended by the City and Guilds Examiners for electrical installation work, has been considerably revised. After the usual introductory matter on units, definitions, resistance data, etc., an account is given of boilers, engines and generators, and there are sections on road traction and notes on electric tramcars. Power transmission and cables next receive notice, and there is an adequate section dealing with lighting, illumination searchlights. The matter dealing with wiring, jointing and tests of insulation is exceptionally complete. The chapters on instruments and accumulators are brought up to date, and we notice several special subjects. Other special sections are those devoted to "Electricity and the Cinematograph" and Electric Welding. At the end there are useful notes on preparing specifications and the usual list of supply companies. In view of the size of the work and the considerable amount of information included, the cost of the diary (3s. net) is still very moderate.

The Woman Engineer (March, 1921).

This publication, issued quarterly, is the organ of the Women's Engineering Society. A feature of the March issue is the inclusion of particulars of societies which admit women to their ranks, and the views of prominent engineers on the position of women in engineering are quoted. An article by Mr. L. Gaster on "Illuminating Engineering" points out that there should be favourable opportunities for the services of women in this field, and it is remarked that the Illuminating Engineering Society has, from its inception, offered equal facilities for membership to men and women.

4

The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by LEON GASTER

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EDITORIAL.

Motor Car Headlights.—Ideal Requirements and Practical Solutions.

It will be recalled that the general requirements to be fulfilled by motor-car headlights were considered in a discussion before the Illuminating Engineering Society opened by Mr. J. W. T. Walsh on March 31st last year,* when particulars of various efforts to frame regulations for the benefit of both drivers and the public were given. Most of these regulations, such as those devised in the United States, recognise the desirability of limiting the beam below a certain horizontal level, so as to diminish the liability of glare to persons facing an opposing headlight. It was evident, however, that the problem involves some degree of compromise between the requirements of a driver who desires to be able to see objects a sufficient distance ahead of his car, and those of pedestrians or other drivers facing an approaching motor-vehicle, whose eyes are apt to be dazzled by a powerful beam.

After this initial survey of the problem the question was taken up again by Major A. Garrard in his paper read before the Society on March 17th this year, wherein ideal requirements are defined and practical solutions suggested. It would naturally be an ideal solution if one could discover

* ILLUMINATING ENGINEER, April, 1920.

some means of modifying the light in such a way as to remove its dazzling properties without impairing its penetration. Colour-treatment, *e.g.*, the use of yellowish glass, has been suggested as beneficial, but the effect appears to be comparatively slight, and at present we cannot see any immediate prospect of a solution on these lines.

Major Garrard accordingly fell back upon the next best alternative, namely, the direction of light from the headlamp in such a way that it does not unduly dazzle the eyes of others. This aim has to be reconciled with the requirements of the driver, and Major Garrard suggests three broad qualities desirable in the beam. There is firstly a fairly wide but relatively dim beam with a well-defined upper limit 3–4 feet from the ground, so as to illuminate hedges and ditches and the road in front of the car; next a central broad but shallow penetrating beam of much greater intensity for illuminating the road ahead, also with a well-defined upper limit 3–4 feet above the ground; finally a diffused and subdued beam of very wide angle, which is, however, of less importance than the first two requirements.

It will be noted that confining the beam below three or four feet above the ground only strictly achieves its object when the road is horizontal. On a sudden down-grade light will shine in the eyes of others facing the car, on a sudden upward grade the beam will strike the ground ahead of the car and reduce the range of vision. It is suggested, however, that such conditions only operate, as a rule, for small intervals insufficient to detract from the general advantages of the principle laid down. As regards intensity of beam Major Garrard suggested that a beam-candlepower 300 times that of the lamp employed should be sufficient. (This multiplying ratio appears to be often exceeded in practice, and should not be difficult to attain.)

The most difficult problem, which, however, has been met with fair success in various existing forms of headlights, is to confine the beam *strictly* below the specified level. If the boundary is ill-defined the effect of dazzle will be more or less present. Major Garrard considers that the desired limitation can only be satisfactorily effected by lamps utilising at least one spherical focusing or projecting lens or objective (including the Mangin mirror).

This is a technical problem which may be commended to designers of headlights. It is at least evident that the discussion of these matters has narrowed down the ground for enquiry, and that the principles to be followed in headlight design are becoming more clearly defined. An interesting suggestion of the lecturer was that in this and other European countries where the roads are exceptionally good and permit fast driving a corresponding high standard of safe illumination is needed. This will become even more evident when, as is ultimately possible, the number of motor-driven vehicles per person approaches the index figure in the United States (at present approximately ten times as great as in this country). It is therefore desirable that there should be in existence permanent Joint Committees of Enquiry, such as that appointed by the Illuminating Engineering Society, whose Chairman, Mr. Worby Beaumont, kindly presided at this discussion.

Tests for Motor-Car Headlights.

Assuming that the requirements expected from a satisfactory motor-car headlight have been satisfactorily defined, the question of suitable specifications and tests arises. As is well known this matter has been studied by the Committee on Automobile Headlighting Specifications of the American Illuminating Engineering Society, which, we understand, is now completing the revision of its specification. Briefly summarised it demands: (1) a *minimum* of 4,800 candlepower, measured on a level surface 200 feet ahead of the vehicle; (2) a candlepower *not more than* 2,400, measured 100 feet ahead of the car and 60 inches above the level surface on which the car stands; (3) *not more than* 800 candlepower measured 100 feet ahead, 60 inches above the level surface on which the car stands and 7 feet or more to the left of the axis of the car; (4) a candlepower of *not less than* 1,200, measured 100 feet ahead of the car, at some point between the level surface on which the car rests and a point on a level with the centres of the lamps and 7 feet to the right of the axis of the car. It will be observed that (1) and (4) prescribe minimum candlepowers in the interest of safe driving, while (2) and (3) limit the candlepower in certain directions with a view to avoiding glare. It is, however, an interesting question whether glare can be sufficiently prevented by defining candlepower in this way; or whether, as Major Garrard has suggested, a definite line of demarcation between the powerful section of the beam and the relatively subdued fringe of light is essential.

The specification also defines the nature of the tests to be made on headlights by an appointed authority in order to ascertain whether the specification is complied with, an interesting provision being the retaining of two pairs of samples, one at the laboratory and one returned to the State authority for purposes of record. We understand that the revised specifications are now adopted by the States of Connecticut, Maryland and New York.

There is much to be said for the practice of conducting tests of headlights in the laboratory, and issuing certificates that they comply with certain approved requirements such as those indicated above. We have always been in favour of government by consent, and in this country the policy of making such tests compulsory might be regarded as premature. But even assuming that they were voluntary the issue of such certificates would do much to raise the general standard of headlights, and would pave the way for the ultimate adoption of legal safeguards. This matter seems to be one that might, in the first instance, be undertaken by the R.A.C. in co-operation with other bodies.

An alternative to detailed laboratory tests would be the devising of simple testing devices such as might be applied to a car at any point in its run, and it appears that the form of disc exhibited by the Chairman at the recent discussion of the Illuminating Engineering Society in this country has promising qualities for this purpose.

Gas Lighting, Past, Present and Future.

In a paper under the above title, recently read before the American Illuminating Engineering Society by Mr. Howard Lyon, it was remarked that the world seemed to have reached a stage when economy in the use of the stored energy of the earth had become of paramount importance. There is therefore a special incentive at the present time towards research in lamps and lighting appliances with a view to greater efficiency in the production of light. In one respect artificial light stands in a more favourable position than many other commodities. True, the cost of gas and electricity has unavoidably increased during the war. But the considerable advances in the efficiency of lamps and the design of lighting appliances made during the last decade are such that the cost of producing a given *illumination* on a certain area is probably even now not greatly in advance of what it was about ten years ago.

Much attention has been given to the improvements made in electric lamps, but changes of equal moment have been taking place in the gas industry, which may have important consequences in the future. Mr. Lyon, in the paper referred to above, alluded to the tendency towards the rating of gas in British Thermal Units—a tendency which in the United States has been favoured by the increasing cost of oil, formerly used for enriching in order to give high candlepower. In gas lighting we have a somewhat complicated problem, but the number of factors concerned is in itself an indication of the great possibilities of progress. We have first the quality of gas utilised, next the design of the burner to get the most efficient conditions of combustion, and finally the manufacture of the mantle by which the heat energy is converted into a visible form. In all three sections advances are possible. Mr. Lyon, for example, drew attention to the great importance of flame temperature. With four different qualities of gas mentioned flame-temperatures in the ratio of 1·06, 1·09 and 1·14 were recorded. These may seem slight variations, but when it is recalled that the light yielded *varies as the 11th power* of the flame temperature they become significant. Thus a change of 1 to 1·14 means that the light is more than quadrupled.

Flame temperature depends also on the design of the burner, and here the question of the amount of air needed for complete combustion also becomes important. Thus, he remarks, that if a burner draws in only 2·5 volumes of air to one of gas (of the quality used during recent years) one cannot get satisfactory incandescence without the mantle being surrounded by a chimney. But by increasing the amount of air sucked in to four of air as compared with one of gas, chimneys may be dispensed with, and a substantial saving in glassware made.

A paper by Mr. E. H. Maurer, read simultaneously with that of Mr. Lyon, described the methods of testing adopted by the Consolidated Gas Company of New York. It is interesting to note that lamps are now rated in lumens per B.Th.U. and that such matters as life tests of mantles, the absorption of light by glassware, etc., were systematically studied. According to the discussion it would appear that semi-indirect lighting with gas is making considerable headway in the United States. On the other hand it was remarked that in that country comparatively little use is still made of high pressure gas lighting, which is such a familiar feature in European cities.

L. Gaster.

TRANSACTIONS

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The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

"MOTOR-CAR HEADLIGHTS: IDEAL REQUIREMENTS AND PRACTICAL SOLUTIONS."

(Proceedings at a meeting of the Society held at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C., at 8 p.m., on Thursday, March 17th, 1921.)

A MEETING of the Society was held at the House of the Royal Society of Arts at 8 p.m., on Thursday, March 17th, Mr. W. WORBY BEAUMONT presiding. The minutes of the last meeting having been taken as read, the HON. SECRETARY read out again the names of applicants for membership announced at the previous meeting, and these gentlemen were formally declared members of the Society.

The CHAIRMAN then called upon Major A. GARRARD to read his paper entitled **"Motor-Car Headlights: Ideal Requirements and Practical Solutions."** Major GARRARD presented a summary of efforts that had been made to reconcile the requirements of the drivers of motor vehicles, who needed a powerful beam to distinguish objects ahead, and those of pedestrians or drivers of other vehicles whose eyes were apt to be dazzled by the brilliancy of the beam. The paper was illustrated by a variety of diagrams, and the conclusion was drawn that the most practical solution of the problem is to aim at confining the beam below a certain level, so that it illuminates distant objects without impinging on the eyes. In the course of the discussion various headlights were exhibited in which an effort was made to comply with this condition.

The CHAIRMAN, in opening the discussion, referred to the work of the Royal Automobile Club in devising a measure of the range and dazzle of lamps, and in the ensuing discussion Mr. D. RITCHIE, Dr. S. MAYOU, Mr. M. HARTRIDGE, Mr. A. BLOK, Captain H. F. WILKINSON, Mr. A. E. PARNACOTT, Captain STROUD, and Mr. L. GASTER took part. Major GARRARD briefly replied to some of the points raised in the discussion.

After a vote of thanks to the author and the exhibitors of apparatus, the CHAIRMAN announced that the next meeting would be held on April 26th, when there would be a discussion on **"Ship Lighting in Relation to Comfort, Safety and Efficiency."**

"MOTOR CAR HEADLIGHTS: IDEAL REQUIREMENTS AND PRACTICAL SOLUTIONS."

By Major A. GARRARD.

(Introduction to a discussion that took place at the meeting of the Society held at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C., at 8 p.m., on Thursday, March 17th, 1921.)

VARIOUS attempts have been made to define dazzle from headlamps, but no definition has, I believe, met with general assent. I do not propose to add to the number, but will merely refer to one aspect of the question which depends upon the structure of the eye. Briefly, the eye consists of a bi-convex lens of special shape and varying refractive index by means of which an inverted reduced image of an object is formed upon the retina, which is a surface having a number of minute parts sensitive to light, communicating with the brain and known as rods and cones. When the eye is exposed to light from a small source a very minute concentrated image is formed on the retina and has a much more painful effect than if the same total amount of light were received by the eye from a number of different sources. For the sake of illustration assume two conditions :—

(1) The eye placed at a point in daylight where the illumination as measured by a photometer has a certain value.

(2) The eye placed at a point where the illumination has the same value but is obtained from a small source such as a headlamp or the filament of a gas-filled electric bulb.

In (2) the light entering the eye is substantially parallel and forms a small, painfully bright image on the retina, while in (1) the light approaches from various directions and the image formed on the retina is much more diffused and correspondingly less intense. It will thus be seen that the effect on the eye of a concentrated source of light cannot be measured merely by the photometer. Account must also be taken of the dimensions of the source. This consideration would point to the desirability of a large source of light or a multiplicity of point sources, but this cannot be regarded as a satisfactory practical solution of the difficulty, and reference has been made to it merely with the object of making basic principles clear.

It will be well to consider first in general terms exactly what headlamps are required to do from the driver's point of view and, later, exactly how it is possible for them to do it. Broadly, non-reflecting objects are seen by means of light which impinges on them and is diffused in all directions. Perfect reflecting objects cannot be seen since the light which strikes them is reflected in definite directions and forms virtual images of the source. Imperfect reflecting surfaces, such as wet roads, which combine these two effects, tend to confuse a driver.

The beam from a headlamp projects light forward and this light when it strikes a non-reflecting or matt object is diffused in all directions and the object is thus visible from all points of view, including that of the driver. Colour by itself does not appear to be of much consequence at night, but the shade or tone, that is the lightness or darkness of the surface, is of importance. Tone values can be compared with some exactness, independently of colour. It is probably strictly correct to say that the driver of a car sees almost entirely by contrasting tones which form silhouettes against one another. The difficulty of seeing the wearer of a dark coat is due generally to the dark surface of the road. Such a coat on a light background, such as is provided by a white road, is seen at a much greater distance. Movement of the object across the line of sight also facilitates vision.

The driver's capacity for seeing objects by means of his headlamps is thus seen to depend upon :—

(A) The intensity of the light which actually strikes the object.

(B) The character of the surface of the object.

(C) The contrast with the background.

It is fully recognised that no headlamp will be ultimately satisfactory which does not comply with two conditions :—

(1) The driver must be able to see obstacles a sufficient distance ahead to enable him to pull up in due time when travelling at a reasonable speed, and he must also see sufficient of the objects off his direct line of vision and progress, *e.g.*, hedges, ditches, etc., to act as a guide.

(2) Other road users must not be seriously inconvenienced.

These requirements are to some extent antagonistic and the present problem is the obtaining of a practical distribution of light which will satisfy both conditions.

The ideal solution would appear to be some modification of the character of the light emitted which would remove its dazzling properties without impairing its penetration. Light of such a character has yet, I believe, to be discovered. Colour treatment of the light itself, such as the use of yellowish glass, said to be effective in fog, has very little effect other than a reduction of penetration in ordinary circumstances.

The use of coloured spectacles or coloured glass on the windscreen of a car is, I think, nothing more than a temporary palliative. While it certainly reduces the troublesome effect from headlamps, the vision is also limited at a time when it should be unobstructed or undimmed. If a small piece of coloured glass is attached to the windscreen it is difficult to find a convenient position which will not interfere with ordinary vision.

Leaving then to the future, probably distant, the possibility of light of a penetrating but non-dazzling quality, two alternatives only remain :—

(1) The protection of the eyes. This, as stated above, is hardly practicable.

(2) Directing the light from the headlamps in such a way that it does not strike the eyes of others.

The latter of these two alternatives is the only one which has been generally considered. It is necessary, I think, to refer to two distributions of light only. The first is the "three-quarter" beam, proposed, I believe, by the National Physical Laboratory before the War when acetylene headlamps were in the majority. In this beam the upper right-hand quadrant is cut out so that approaching motor-cars, etc., are illuminated up to a height of 3 or 4 feet only. Such a beam is not of much use on curves or winding roads, and is of no benefit to pedestrians or to led horses approaching the car on their right-hand side of the road, and it does not appear to have been applied in any country.

In the second distribution of light in question all, or nearly all, the bright penetrating beam is kept below an horizontal plane 3 or 4 feet from the ground. This is broadly the aim of the regulations in force in many of the American States, and, I believe, in parts of Australia.

It is now necessary to consider in more detail the essentials of a headlamp which will so keep the light below the eyes, and will at the same time give sufficient illumination for safety both of the vehicle and of others on the road. I think that such essentials may be arranged under three headings :—

(1) A fairly wide but relatively dim beam with a well-defined upper limit 3 or 4 feet from the ground so as to illuminate the hedges and ditches and the road in front of the car. This beam should preferably be of varying intensity so as to direct more light upon the more remote objects, in, say, the middle distance.

(2) A central broad but shallow penetrating beam of much greater intensity with a well-defined upper limit 3 or 4 feet from the ground for distance observation. This might extend about 4 degrees on each side of the axis, although it is difficult to suggest exact limits as the best results are probably obtained when the bright beam is shaded off fairly steeply into the wide beam.

(3) A diffused or subdued beam having a very wide angle and corresponding to the light obtained direct from the filament of an ordinary electric headlamp without reflection. I think that this light is of very much less importance than the beams defined under headings 1 and 2, but it may have a useful psychological effect; the same may be said

of a comparatively bright beam inclined upwards at such an angle that it is above the eyes of other road users.

The effect of such a composite beam on a screen is illustrated diagrammatically in Fig. 1.

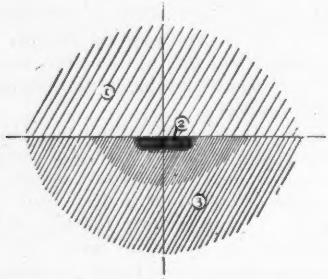

FIG. 1.—Showing effect of composite beam.

The requirement of a well-defined upper limit to the beam referred to under headings 1 and 2 can only be fulfilled exactly on roads which are horizontal or of uniform slope. On a sudden downward grade the light will shine in the eyes of others in front of the car, while on a sudden upward grade the light will strike the ground ahead of the car and reduce the range of vision. It will be found, however, that on most roads these conditions operate for very short intervals, quite insufficient to detract seriously from the general advantages of the principle.

Some such distribution as that detailed above is necessary to enable the light available to be most efficiently utilised. The efficiency of a headlamp cannot be stated as simply as the efficiency of a mechanism, since several results different from one another are required. The bulb of an electric lamp emits light in all directions with approximately equal intensity, although there are variations according to the aspect from which the filament is viewed, *e.g.*, edge on or broadside on. The headlamp is merely an apparatus for collecting as much as possible of what may be referred to as the spherical candlepower and concentrating it in a given direction. One measure of efficiency, and probably the most important, is the multiplication in the main penetrating beam, of the strength of the source. The candlepower of the beam of a parabolic headlamp may be 900 or more times the candlepower emitted spherically in all directions from the source, but such a beam will be very narrow and will give inadequate side illumination. If the beam is made wide to illuminate a larger field the intensity decreases accordingly. It is difficult at the present stage to suggest definite figures, but it is probable that a penetrating beam 300 times as bright as the source is quite sufficient. Another measure of efficiency is the fraction of the total spherical candlepower which is utilised in the several necessary ways.

One other aspect of the case has to be considered, namely, the presence of patches or striations. Such effects are due both to irregularities (generally circumferential spinning marks) in the reflector and to the magnified convolutions of the filament; their effect on the road and hedges, particularly at close range, is confusing. The intensity of the light in a bright or dull patch in the main beam may differ by 50 per cent. from the average.

The question of satisfactory driving illumination is not merely one of intensity. The perfect headlamp would appear to be one in which all objects far or near are subject to the same intensity of illumination; that is, the foot-candle figure is constant. The spherical candlepower required to illuminate each object will be proportional to the square of the distance from the headlamp, and the variations of beam intensity at various angles off the axis will be very great. If such a condition could be complied with it is probable that the cutting out of the whole or part of the upper portion of the beam would have very little adverse driving effect. If too much light is thrown down on to the road close to the car the distance visibility is impaired, owing probably to contraction of the iris of the eye by reason of the diffused light from the road shining therein, although it may be slightly off the line of direct vision.

The square of the distance law also accounts for the range of illumination increasing much less rapidly than the candlepower.

In Fig. 2 an attempt has been made to show what great variations of intensity

at different parts of the cross-section of the beam are necessary if the above conditions are to be complied with even approximately.

The lower part is a plan of rather more than 300 feet of a road, say 30 feet wide, while the upper part also shows a plan giving two polar curves, A and B, curve B being practically the continuation of curve A to one-tenth the scale. In each curve the length of the radius or arm is inversely proportional to the square of the sine of the angle from the axis XX, and they represent the necessary variations of illumination to enable objects along, say, the hedge to be uniformly illuminated, that is subject to the same foot-candle power on the assumption that the surfaces viewed are

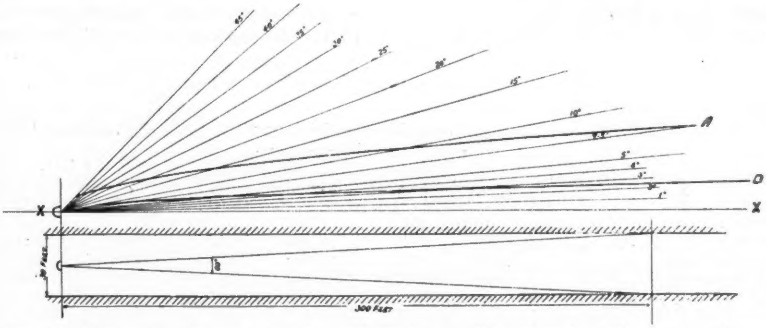

FIG. 2.—Illustrating the great variation of intensity at different parts of the cross section of the beam necessary to get suitable distribution of illumination.

at right angles to the light which strikes them. For example, if the intensity of the light which is emitted at 45° is called unity, the intensity of the beam 3° off the axis will be 180, and this corresponds to a point in the hedge of a 30-ft. road 300 feet ahead. The intensity in a direction 2° off the axis is 410.

This is put forward as illustrating the necessity for steep gradations in the beam if the light is to be economically distributed, and also to emphasise the principles to be kept in view when designing headlamps. Expressed otherwise, if the car is moving in a straight line, all objects along the hedge are illuminated with the same intensity as the car approaches them, that is, are equally visible at all distances within the range of the lamps. A curve satisfying this rule applies to roads of any width, but the variations of intensity with distance ahead need not be so great on wider roads. The variations of intensity on the road in front of the car should, on the other hand, be much greater.

It is necessary to emphasise the importance of a fairly sharp boundary between the main penetrating beam and the space above it. If the boundary is indefinite and the change from bright light to darkness therefore gradual, it will not be possible to direct the brightest part of a beam upon the legs and lower part of the body of a pedestrian without also directing into his eyes some very bright light. An indefinite boundary at short distances of about 20 or 30 feet may be satisfactory, but at distances of 100 or 150 feet it is obvious that vague demarcation would result in a pedestrian being either dazzled or not illuminated.

A bright beam directed downwards upon the road is quite ineffective in picking out relatively distant objects, and if too strong is definitely harmful, as mentioned above, in impairing the sensitiveness of the eye for distance vision.

The considerations which tend to detract from the effectiveness of the definite line of demarcation are as follows: Definition deteriorates as distance increases and variations of level due to springing of the vehicle and to changes in the contour of the road are also greater at greater distances ahead. At the same time the intensity of the light decreases with the distance. To state

the matter conversely, as a road-user is approached by or approaches a car fitted with such lamps the non-dazzling conditions improve, leaving a considerable distance within which dazzle is practically impossible.

It is comparatively a simple matter to examine the effects and characteristics of different lamps in a room by throwing the light upon a screen or wall, but it is much more difficult to do this on a road.

It is obvious that a brilliant beam projected into the distance will not show any result to a driver or observer behind the lamp until it strikes some object. It is, in fact, until then non-existent as far as the driver is concerned. It is failure to appreciate this point that makes so many drivers content with lamps which give small distance penetration and merely send a flood of light over a wide angle embracing road, hedges, tops of trees, etc., the beam being too bright at close quarters and too dim for penetration. Such an effect is given by at least one make of American diffuser or by frosted glass. The first impression is one of satisfaction at the uniform light on all the near objects, but a person who walks away in front of a standing car so equipped is very soon out of sight. It must be emphasised that the most important characteristic of a headlamp is the distance beam if any reasonable speed is to be attained safely, and the greatest difficulties arise in obtaining brightness right up to the line of cut off. The tilting adjustment of a lamp is clearly of much importance, but on the road it is extremely difficult to know whether the bright beam has been given its correct elevation when the limits are indefinite. With a definite upper limit this difficulty is removed.

Having now defined in general terms the desirable characteristics of a non-dazzle headlamp it will be well to consider more specifically the necessary candlepowers required at different points and practical methods of measuring this candlepower and its effects.

An extensive series of tests was carried out in March, 1918, in America, under the auspices of the American Illuminating Engineering Society, and the Society of Automobile Engineers, with the object of obtaining the judgment of a large number of observers (49) on two points.

(1) The intensity of illumination required to render visible a man in dark clothes at distances of 150 and 250 feet from the observer in the car.

(2) To determine how much glare each observer would tolerate from the headlamps of another car 100 feet away when he was sitting behind his own headlamps adjusted to his requirements for vision at distances of 250 feet.

	C.P. required for visibility at 150 feet.		C.P. required for visibility at 250 feet.		C.P. causing glare at 100 feet.	
	C.P.	Ft. C.P.	C.P.	Ft. C.P.	C.P.	Ft. C.P.
Average	3,200	·142	6,980	·112	239	·024
Highest values	10,000	·445	18,300	·293	850	·085
Lowest values	1,000	·0445	1,300	·021	80	·008

As might be expected, the results varied enormously.

The report on the tests pointed out that it included only stationary motor-vehicles, unmodified parabolic headlamps, moving objects (men in dark clothes), road surface of medium dark colour, and that caution is therefore necessary in attempting to apply the above results to a practical case. The results are, however, indicative of the order of magnitude of the illumination required for driving or permissible in the eyes of others.

The Regulations apparently in most general favour in the U.S.A. recommend that as measured at a distance of 100 feet the illumination should be such that the spherical candlepower or visibility

figure between the ground and a point 42 inches above it is not less than 4,800, while the candlepower or glare value above the level of 42 inches is not more than 2,400. Lower values are also specified for points 10 feet off the centre line of the car. This distance is really very short, and very poor definition of the beam is sufficient to enable these conditions to be complied with, but at 200 feet it is much more difficult. It will be noted that the visibility figure is lower than the average value obtained in the above tests would suggest as necessary, while *the glare value permitted is nearly ten times the average value regarded as tolerable.* Even the more exact and definite of the regulations in force in the U.S.A. are thus a makeshift or compromise, and may be looked upon as an attempt to define the best conditions practicable, although obviously falling very far short of what is desirable. To quote from another American report on the subject, it appears to be generally recognised that "there is no satisfactory solution of the problem without radical changes in the construction of the lamps, and a clearer understanding of the principles involved on the part of those equipping and using automobiles."

The great variations in the sensitiveness of individuals, making every allowance for errors of observation, also the very low glare figures obtained, clearly make it desirable that the light to be allowed immediately above the bright beam should be reduced to an extremely low figure, *i.e.*, a figure of no practical illuminating value except at quite short distances.

A recently devised visibility gauge of some importance is the R.A.C. Standard Anti-Dazzle Disc, which is in effect a combined object and background. It consists of a black circular card having on it a number of irregular grey shapes. A definite shade or tone of grey is obtained by alternate black and white lines of definite dimensions. The card is used as a standard object, and the distance at which the different shapes become defined gives a measure of the intensity of the illumination on the card at any given part of the beam. It may thus be looked upon as a kind of simple photometer giving a sufficient degree of accuracy for the purpose. It should be remarked that the shape of an object becomes quite definite fairly suddenly as the object becomes closer, so that there is only a matter of a few yards between the shapes showing quite definitely or being quite indefinite in outline. It is possible that this method, with suitable safeguards as regards the employment of observers with normal vision, will enable a comparative standard of headlamp illumination to be laid down.

The various general considerations bearing on the prevention of dazzle and adequate driving illumination have been reviewed and an effort made to put these requirements into definite form. It is now necessary to consider how such requirements can be complied with in a simple practical manner. The main difficulties are, I think, two in number. One is the obtaining in a simple way, and simplicity must be emphasised, of sufficient definition between light and darkness, and the other is the obtaining of sufficient concentration and corresponding intensity in the main projecting or distance beam.

The first proposition I should like to put forward is of a somewhat negative character. It is that the results desired cannot be obtained by means of an ordinary parabolic headlamp using attachments to bulbs, mechanical directing devices or special front glasses or lenses, so-called, in place of the ordinary glass.

In order to deal with this part of the subject adequately it will be necessary to refer briefly to some of the elementary properties of parabolic headlamps.

Such a headlamp accurately constructed would project from a perfect point source a beam of light consisting of a number of parallel rays. A cross section of the beam would at every point be a circle of diameter equal to the diameter of the paraboloid. In addition the lamp would emit direct from the source a cone of light having a vertical angle dependent upon the focal length and depth of the paraboloid. This is merely a theoretical conception as impossible of actual attainment as Euclid's point having position but no magnitude.

The ordinary commercial paraboloidal reflector is often optically very far from truly parabolic, and most spun reflectors show to a greater or less extent circum-

ferential irregularities due to the spinning tool. The light emitted from a reflector can be examined readily by holding a piece of white paper in the beam and viewing it from the side remote from the reflector.

Obviously no electric lamp filament can even approximate to a point and the effect of size is multiplied many times by the reflector. The difference between the beam obtained from the vacuum bulb and that from the gas-filled bulb in point of size quite apart from colour is well known. In the vacuum bulb it is usual, though not essential, to arrange the wire as a helix with its axis lying along the axis of the reflector, the dimensions of such helix being—diameter $\frac{1}{8}$ in. to $\frac{1}{4}$ in.—length $\frac{1}{3}$ in. to $\frac{1}{2}$ in. according to closeness of winding and candle-power. In the gas-filled bulb the filament wire is arrayed in a helix of $\frac{1}{32}$ in. to $\frac{1}{16}$ in. diameter in one or two short lengths, the filament being much more compact. The bulb is filled at a very low pressure with an inert gas which will not chemically combine with the material of the incandescent filament, but which serves to conduct away heat and allows the filament to be run at a higher temperature than would be possible in a vacuum.

Imagine, for the sake of illustration, that the filament is spherical so that its dimensions are the same when viewed from any direction as shown in Fig. 3.

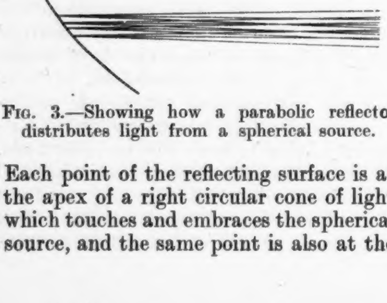

FIG. 3.—Showing how a parabolic reflector distributes light from a spherical source.

Each point of the reflecting surface is at the apex of a right circular cone of light which touches and embraces the spherical source, and the same point is also at the apex of a reflected cone of light having the same vertical angle. The vertical angle depends upon (*a*) the size of the source (which in this case is constant) as viewed from the point of the reflector in question, and (*b*) the distance of the source from the point on the reflector. The beam is thus composed of an infinite number of such cones of light having vertical angles dependent upon the distance between the source and the point on the reflector corresponding to each such cone or pencil. The cone of maximum divergence or vertical angle is obtained by reflection along the axis, that is, it depends upon the focal length of the reflector. The divergence of the cones from other points on the reflector decreases as the distances of the points from the focus increase. In practice, of course, the stem of the bulb almost invariably lies along the axis. Also all light which after reflection has to traverse the glass of the bulb loses both in intensity and in accuracy of direction, particularly where it is nearly tangential to the bulb. The final result then is a beam of light of conical shape the angle of which depends upon the focal length of the paraboloid and the dimensions of the filament. No filament is actually spherical, and the beam of light varies accordingly while its cross section when projected on to a wall is clearly very streaky. If a card with a small hole be held in front of a lamp the effect of various parts of the reflector may be examined and it will be found broadly that each hole forms a distorted image of the filament as viewed from the point then under examination on the reflector.

The beam from a headlamp may thus be looked upon as composed of an infinite number of rays travelling in all directions within the limits of angular divergence from the axis pertaining to the focal length of the reflector and the dimensions of the filament.

Hitherto it has been assumed that the lamp is properly focused, that is, as nearly focused as a filament of finite size can be. If the filament is drawn back behind the focus all the rays diverge outwards until a dark space may occur in the middle of the field, while if the

filament is brought forward in front of the focus the rays converge, cross and finally diverge.

Having thus briefly reviewed the principles on which the ordinary parabolic headlamp works, it is possible to examine more readily the effect of various anti-dazzle devices.

The majority of the glass attachments for the fronts of lamps are of American origin and broadly perform either or both of two functions, *i.e.*, deflection and diffusion.

The majority have deflecting prismatic surfaces formed on one side arranged in various ways. Many are arranged horizontally so that the main beam is deflected 2° or 3° downwards to bring the brightest part below eye level without tilting the lamps, while others are inclined

that the principal advantage accruing to other road users from the adoption of such anti-dazzle devices is the substantial reduction in the strength of the beam due to the lateral dispersion, the deflection downwards of the beam having less practical effect owing to the ill-defined upper limit.

In a few American devices part or the whole of the front glass has a general diffusing effect. In some cases frosting is resorted to while in others convex projections resembling small lenses are formed on the surface so as to cover the whole thereof or leave intermediate flat non-deflecting or non-diffusing parts. The chief merit of these devices resides in the reduction of the intensity of the light but the penetration is then negligible.

	Average C.P. of gas-filled bulb.	Maximum effective candlepower.	Maximum multiplication of source in beam.
(1) Parabolic headlamp (9 in.) with diffusing lens	19·1	750	39·2
(2) Parabolic headlamp (9 in.) with prismatic lens deflecting downwardly and sideways ..	19·1	2,750	144
(3) Parabolic headlamp (9 in.) with diffusing lens	19·1	820	42·9
(4) Parabolic headlamp (9 in.) with prismatic lens	19·1	5,800	304
(5) Parabolic headlamp (9 in.) with very faintly-grained glass sufficient merely to avoid excessive striations	19·1	17,200	901
(6) Parabolic headlamp (7 in.) with upper half obscured and bulb behind focus	15	1,600	106·5

or curved, so as to spread the light out sideways or in some cases to tend to concentrate it. On the other face is frequently found a series of shallow vertical corrugations which spread the beam out laterally so that it is three or four times its former width. The results obtained vary in accordance with the filament and the focusing. In some cases the best results are obtained when the bulb is slightly out of focus. In, I think, all cases it is difficult in view of the absence of a definite horizontal upper boundary to the light to determine at night how to adjust the tilt of the lamp to give sufficient driving light and at the same time keep the brightest part of the beam below eye level. I am of opinion as the result of tests and of reports regarding American driving conditions

A few figures relating to various devices of this character are given herewith, these figures having been abstracted from a report of tests made by the National Physical Laboratory for the Lights on Vehicles Committee of the Ministry of Transport, by kind permission of the Chairman, Sir Henry Maybury.

No curves of illumination are given, but those interested will find such curves and other information regarding some American devices in the Proceedings of this Society for April, 1920.

The next class of apparatus to be considered may be described as the mechanical director in which an attempt is made to confine the light below a certain level or to limit its lateral spread by means of shutters, louvres, deep concentric rings or like devices. Such

apparatus in practice merely cuts off the upper direct rays from the lamp and more or less dims the main beam uniformly in accordance with the amount of obstruction interposed. The cutting off of the upper direct rays probably does more harm than good.

I think that it is obvious from first principles that louvres, etc., cannot be made long enough or arranged close enough together to cut off all or most of the upper rays without also cutting down the intensity of the main beam materially.

The next class of apparatus to be considered may be described as the home-made devices. In America certain State Authorities issue large sheets of instructions showing how headlamps should be focused and adjusted when prismatic and similar glass devices are employed, and also explaining how the lamps may be made to comply by simple devices with those regulations which require all or most of the light to be kept below a certain level. In such instructions it is stated among other things that the upper light can be cut off by :—

(*a*) Placing the filament of the bulb behind the focus of the paraboloid and obscuring the upper half of the reflector or front glass; or

(*b*) Where the focal length of the paraboloid is too short or the bulb too large for adjustment (a) to be carried out, the filament may be arranged in front of the focus and the lower half of the reflector or front glass obscured.

There are two main defects of these methods :—

(1) The beam, which is approximately of semi-circular cross section, is so spread out that the penetration at the middle is materially reduced.

(2) Half the light is wasted.

It is hardly possible to remedy the first defect, but part of the light cut out may be saved by replacing the brown paper or paint on the front glass by a plane mirror or by a semi-parabolic reflector having a focus coincident, not with the focus of the main paraboloid, but with the filament.

In another class of device or remedy similar in principle to that just described, parts of the bulb are blackened or obscured by a metal attachment; the remarks in the preceding paragraph regarding focusing so as to obtain a diverging or converging beam apply also in this case, but the cutout is applied closer to the source of light.

Suggestions probably arising from the character of the war period restrictions have been made from time to time that the dazzling effect of parabolic headlamps could be avoided to some extent by :—

(1) Limiting the candlepower of each of the two headlamps to, for instance, 20 or 24.

(2) Limiting the open front diameter to 6 or 7 inches.

Neither of these suggestions can be regarded as satisfactory. In the first place the candlepower given out by a filament varies approximately four times as rapidly as the voltage, so that it would be quite possible to overrun a bulb by a comparatively small amount, and so obtain a considerable increase of candlepower, although the life of the bulb would be reduced, particularly in the case of gas-filled bulbs with closely wound helical filaments. As an example, a standard 6–7 volt bulb giving, say, 24 candlepower at 6 volts will, when run at 7 volts (that is, an increase of 16·7 per cent.), give about 40 candlepower (that is, an increase of $16{\cdot}7 \times 4 = 66{\cdot}8$ per cent.). Further, in many cases there are variations of 50 per cent. in actual candlepower between bulbs having the same nominal volts and watts, and by the same maker, although such variations could probably be avoided. Another consideration bearing on the practicability of limitation of candlepower has been referred to above. It is the fact that the actual candlepower in the beam depends not merely upon the total spherical candlepower of the source, but upon the proportion projected along the beam and the concentration or cross sectional area of the beam; a greater beam candlepower may be obtained in a narrow beam from a small candlepower at source than in a wide beam from a larger candlepower at source.

In dealing with the question of the open front diameter of the lamp, it is well to examine into the value of the light emitted in certain directions by the bulb. Imagine the light to be divided

up by a series of cones having semi-vertical angles of 10°, 20°, 30°, etc., and having a common axis, namely the axis of the bulb and lamp as shown in Fig. 4. The first cone emits only ·75 per cent. of the total spherical candlepower, the second cone increases this by 2·25 per cent., the third cone accounts for an increase of 3·7 per cent., and so on.

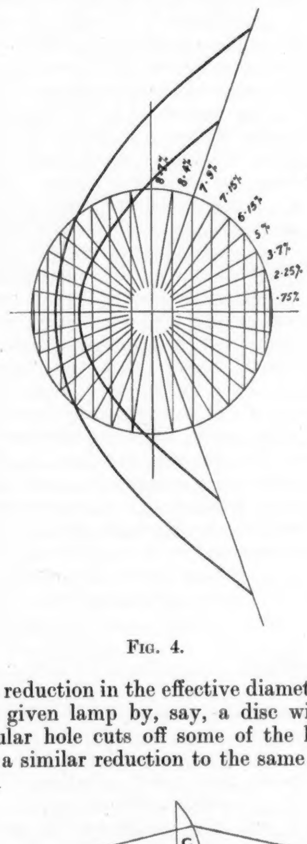

FIG. 4.

A reduction in the effective diameter of any given lamp by, say, a disc with a circular hole cuts off some of the light, but a similar reduction to the same final diameter of a smaller lamp will mean a smaller reduction in the amount of projected light. It is thus possible for a 5 in. diameter lamp of short focal length to project, say, 70 per cent. of the spherical candlepower forward, while a 12 in. lamp of greater focal length and proportionately deep can do no more, although the light from the outer zones may be more concentrated. Each of the two paraboloids illustrated projects forward 67·1 per cent. of the light which emanates from the source. The open front diameter of a lamp by itself has very little bearing on the amount or intensity of light projected.

Having dealt with parabolic headlamps from a somewhat negative point of view, it is now possible to put forward a more positive proposition. It is that the requirements outlined earlier in this paper to be complied with by a non-dazzling lamp giving a sufficient driving light can only be met definitely by lamps employing at least one spherical, focusing or projecting lens or objective, and under this heading is included the Mangin mirror, which may be regarded as a combination of a reflector and a focusing lens.

It is by this method alone that a sufficiently definite line of demarcation between light and darkness is likely to be obtained in a simple commercial manner. This may be illustrated by reference to a simple diagram, Fig. 5, showing a source of light, S, a condensing lens, C, and a projecting lens, P, in which the condensing lens is placed at about the focus of the projecting lens while the condenser is of such a strength that an image of the source is produced at or near the projector. In this way the cone of light collected by the condenser is brought through the projector as compactly as possible. The projector then forms an image of the illuminated condenser at some considerable distance. If the lower half of the condenser is obscured as at *a*, the projector will form an image in the distance

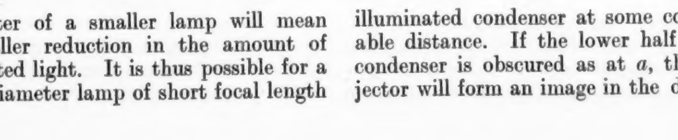

FIG. 5.—Showing use of lenses to obtain definite line of demarcation between light and darkness.

of the upper part, and this image will be the lower half of a circle. If such an image is formed, say, 100 ft. away, it will be proportionately large, and the boundary between light and darkness will be sufficiently well defined at intermediate and at more remote points. A beam of any desired shape could be similarly obtained. Broadly, the advantage of this class of projecting apparatus is that the direction of light is under such control that any reasonable effect can be obtained.

The principal difficulty in the practical application of all such projection apparatus is the necessity for length in order to obtain sufficient concentration and intensity.

In one lamp working on the above principle a number of such optical systems have been combined, so as to obtain variations of intensity at different parts of the beam.

In another lamp two projecting lenses arranged one over the other have been employed and each has collected approximately half the light from a parabolic reflector, the two optical systems having been separated to avoid interference with one another by a longitudinal diaphragm, and definition between light and darkness obtained by suitably-shaped metal members towards the rear end.

The use of the Mangin mirror in headlamps, searchlight and signalling lamps is well known and hardly requires description. But it may be said shortly that the emergent rays of light are so nearly parallel that the shape of an opaque body interposed in the beam close to the lamp remains definite for a considerable distance. It is thus possible to cut out or to deflect part of the beam and so obtain concentration with definition. It is, however, difficult if not commercially impossible, to make a Mangin mirror of such a shape as to collect a large percentage of the light from any source emitting its light spherically.

When considering this question it is well to realise that the road motor era is only at its commencement. Even now the United States, with twice the population of this country, has approximately ten times the number of motor vehicles. There is little doubt that the amount of fast night driving in the future all over the world, particularly among commercial vehicles both for goods and passengers, will be immensely greater than at present and will greatly magnify the importance of a solution of the headlight problem.

It would appear that the American devices have only been tolerable by reason of the slow driving necessitated by the generally bad cross-country roads there. In this country and in many other European countries a much higher standard of safe illumination is necessary and will become more so, while the road improvements now going on in the States will at no distant date render an effective solution equally necessary there.

DISCUSSION.

The CHAIRMAN (Mr. Worby Beaumont) remarked that it was a matter of common knowledge that annoyance was apt to be caused to pedestrians and drivers of vehicles by the excessive, and as he might say "untamed," headlights used on some motor-cars. Drivers of vehicles, in particular, were apt to be distracted by the dazzling effect of such rays, as they were frequently sitting in the full glare of the beam. Major Garrard had given a great deal of attention to this problem, and his paper explained why such lights were objectionable, and discussed possible methods of reconciling the needs of the driver of a car using a headlight and the requirements of those who were illuminated by this powerful beam.

The Chairman also alluded to a paragraph in the paper referring to "a recently devised visibility-gauge." The R.A.C. standard anti-dazzle disc utilised a black card having on it white lines arranged in different directions and grouped in five irregular shapes. This disc was exhibited and explained. The problem resolved itself into three main questions: (1) What was the cause of the annoyance? (2) How was that cause to be brought within a suitable specification of illuminating value; and (3) Having defined the cause in terms of direction and quantity, what practicable steps

could be taken to meet the requirements by devising headlights which would not be a nuisance and a danger to others on the roads ?

It would appear that the primary cause of the trouble was the desire for high speeds at night, as such speeds necessitated the driver being able to see clearly any obstacles a certain distance ahead. Hitherto this speed had only been described as a "reasonable speed," and most of those using motors were in doubt as to what this term implied. High speeds naturally demanded the illumination of the road for a longer distance ahead than would be necessary for a slow-driven vehicle. A powerful beam must accordingly be used to get the requisite illumination, and this might give rise to dazzling. Headlights varied much in construction, *e.g.*, in the choice and arrangement of lenses and mirrors, the position of the source, and its candlepower. Limitation of candlepower alone would not solve the problem. It was necessary to have some measure of the range and dazzle of lamps. He had been able to obtain from the Royal Automobile Club a copy of the vision and distance identification disc, which had been devised by the Club, and would probably become the standard visibility gauge or standard anti-dazzle disc.

Major GARRARD, referring to the disc, explained that at about 200 feet distance it appeared to be merely a black disc having on it a number of irregular grey shapes. Two or three steps forward enabled five distinct patches to be located, but their actual outlines could not be determined. There was little doubt that the disc did set a standard of distance illumination with comparatively small variations. Another use of the disc was as follows. It was held up behind the car and to one side of it and faintly illuminated, and the observer walked along the beam straight towards the car. The distance at which he could just see the shapes on the disc was taken as a measure of the non-dazzling properties of the headlights employed.

The CHAIRMAN, before calling for further discussion, suggested any exhibits of headlights should be shown.

Captain E. STROUD then exhibited and briefly described the Holophane anti-dazzle headlight, remarking that this had been explained in fuller detail at the meeting of the Society held in March, 1920.

Mr. D. J. RITCHIE said that he regretted that considerations of business prevented him at the moment from explaining the construction of his exhibit, the "Moonbeam" lamp, of which two examples were shown. He would throw the light on the screen, and it would be seen that the beam of the first lamp embodied more or less fully the principles laid down by Major Garrard in his paper. In working out his lamp he (Mr. Ritchie) had attempted to put into practice the precepts laid down at the Ministry of Transport last summer by Major Garrard, and more recently by Major Clements and Mr. Perrin. He wished to take the opportunity of thanking these gentlemen for their assistance in elucidating one of the problems of "dazzle"—the somewhat elusive problem of what precisely was required, which had caused him and no doubt others considerable difficulty. It would be seen that the beam consisted of a small bright central area, forming the penetrating beam; surrounding this on three sides was an area of secondary intensity, and outside this again was a third area of still lower intensity. The three areas were graduated into each other, and all were sharply cut off in a nearly straight horizontal line at the upper edge immediately above the region of maximum intensity. The angle of spread was roughly 45° on each side of the axis—about that of an ordinary headlamp. There was a "top-light" which had been asked for at the Ministry. The bulb used was a "Z" 36-watt.

The beam of the second lamp showed substantially the same characteristics, but had considerably less light in the "tertiary" area. The bulb was a 24-watt Ediswan. He had not measured the penetration of these lamps, but it would be about 200 ft.

Dr. S. MAYOU agreed with all the author had said, but he was there chiefly as a student on this question. As a practical motorist he had some experience.

To him the great danger was when he was passing another car with headlamps on it during the period when the eye was passing back to its dark adaptation stage that the danger came because one could not see. He had not seen any light on the road yet that overcame it. He had not seen in use the new devices that had been shown to-night.

Mr. Arthur Blok, referring to the polar curve of candlepower shown in the author's slide No. 2, remarked that the curve was taken back 45 degrees and covered a region considerably behind the frontal zone of the lamp which is the region of practical utility. He asked how far practice approximated to the form of curve shown for the frontal regions. From the table of American tests of visibility quoted by the author it appeared that the foot-candle values were obtained by taking the candlepowers and applying the inverse square law. Some explanation seemed necessary here. They were dealing with headlights which, presumably, approximated more or less to parallel beam illumination. If the beam were truly parallel the inverse square law evidently would not apply and, excepting absorption by dust and the like, the illumination would be independent of the distance ; if, on the other hand, the lamp behaved as a point source the inverse square law would apply rigidly. No doubt the performance of an actual headlight would come between these two extremes. Were the foot-candle values obtained by photometer readings or were they worked out from known candlepower values by applying the inverse square law ? If the latter step had been adopted, how had allowance been made for the parallel component of the beam ?

On the matter of glare he said that he had done a little night riding, and had been struck by the difficulty caused to a driver with a thoroughly dark-adapted eye merely by passing the first lamp-posts outlying a town when coming in from a long dark road. Such lamps might render the eye practically useless for an appreciable time, and the effect of the much fuller flood of light from a passing car might easily cause the thing to assume the dimensions of a disaster. At 60 miles an hour one travelled about 30 yards in a second : if the recovery of one's vision required the lapse of one second there would be time for many awkward things to happen even at half this speed of travelling. It might be possible to prevent the driver's eyes from becoming markedly dark-adapted by directing a part of the light of the headlamps backwards towards the driver. The dashboard or instrument lights sometimes enabled one to avoid the trouble, and he had found that by looking at the bright dials of the instruments while a distant car was approaching the glare of the headlights when seen at close quarters seemed to some extent reduced. But obviously no driver could get visual relief consistently by taking his eyes off the road in any such manner as this.

He ventured to take exception to the use of the term " efficiency " of a headlamp in the early part of the paper, inasmuch as it was used with no regard to the normal meaning of the term, viz., the ratio of output to input. " Performance " or " value " or any kindred term would, he thought, be preferable.

Dr. H. Hartridge asked whether the author could tell him anything about the tests which the R.A.C. standard anti-dazzle disc had gone through. Did the values obtained by it depend on the diameter of the pupil of the observer or on his dark adaptation ? With regard to swivelling lamps, years ago it was permissible to swivel one's headlamps, but this is not allowed by law nowadays. Since lamps are being constructed, however, to give great penetration at a distance, and that assumed that the road was a straight one and the car was going straight along it, if one was to get full advantage out of these headlights it seemed essential to swivel the lamps when turning corners or when passing other vehicles, and it looked as if the legislation would have to be altered in this direction. Possibly altering the direction of one's lights might serve the same purpose as dimming them when passing other road-users. With reference to anti-dazzle devices, it was an interesting point of view that might be worth considering that pedestrians used at night vision given by the rod apparatus of the retina, which reacts well to rays of short-wave length. On the other hand, the cone

apparatus of the retina used by the motorist when driving at night reacts well to rays of long-wave lengths. The rays used by these two pieces of apparatus of the retina were therefore different. Was it possible to limit the light of the motor lamps to those rays of long wave-lengths which would enable the motorist to see and at the same time limit the light rays used by the eyes of the pedestrian to those of short wave-length which would enable him to see sufficiently well in the dark so that when the pedestrian looked towards the car's lamps he would not see any light at all? The difficulty of this suggestion would be to make pedestrians use the necessary coloured glasses at night.

Mr. F. WILKINSON said one speaker had said they would have to go for some other rays of light, but where it was necessary to penetrate a distance he was afraid they would always have a dazzling light. He had found the best solution was to switch off his lights when he saw another motor approaching and to close his eyes for a fraction of a second while passing if the other motorist did not switch off his lights. He was able to see quite well again almost before he had got past the other car. On some roads in the country one only got 18 ft. of carriage-way, but in the towns, where there was often 50 ft., one could swerve to the left. He did not like swivelling headlights. One took a corner at a lower speed than straight driving, and if a driver had to swivel the headlights and steer his car with one hand he would have too much to do and swerve too much unless it was prevented mechanically. In the author's diagram the length of road was 300 ft., and he said he got the same intensity of light throughout, but he pointed to it just where it came to the horizontal, and, assuming that to be 240 ft., was not that the limit of the equal intensity?

Mr. RITCHIE said it seemed a questionable expedient to switch off lights and close the eyes at a specially dangerous moment, supposing a lamp could be made that obviated that necessity. There seems to be an assumption that you must either have glare or insufficient illumination, but he did not think the light was "untamed," as the Chairman put it. The night before last, with two 36-watt bulbs, one a "Z" and the other an Ediswan, he did 40 miles an hour with perfect safety. He watched the obscured part of the field shown by the lamps, and it was clear that the heads of people he met and the drivers of other vehicles were in the dark area and were therefore not dazzled. Last night he did 30 to 35 m.p.h. with 24-watt bulbs. The car and driver were hired, and the man would not be likely to risk his neck and his employer's car. If headlamps could be made which would solve the dazzle problem they might as well be made to obviate the switching up and down. He regretted extremely being unable to describe the construction of his lamp.

Mr. A. R. E. PARNACOTT said that he did a considerable amount of driving, both by day and by night, and his experience was that all forms of lamps gave rise to some degree of dazzle. He had, in certain circumstances, been inconvenienced by an ordinary candle lamp. So far as anti-dazzling devices were concerned, he thought that this was mainly a question of limiting the total luminosity. He had driven at relatively high speeds with paraffin lamps. The eye soon became used to the darkness; unless it was a very dark night indeed, he would prefer to drive without any lamps. The expedient of having a judiciously arranged lamp shining on the driver's eyes so as to prepare him for the effect of an opposing headlight might have a good influence; he had tried the same expedient in order to prepare his eyes for lightning flashes; but the real remedy was to diminish the total amount of light emitted by lamps. The light emitted should be strictly moderate, and sufficient merely to show the overall dimensions of an approaching vehicle; the driver of such a vehicle could then shield his eyes with the hand. Swivelling headlights might also be useful or the beam could be localised by placing the lamp at one end of a tunnel-shaped aperture. Mr. Ritchie's headlight seemed to conform well with the author's requirements.

Mr. L. GASTER (Hon. Secretary) moved a vote of thanks to Major Garrard for his paper, to the various exhibitors, and also to Messrs. C. A. Vandervell and Co. for the loan of a standard battery, from which these various headlights were supplied with current. He also wished to propose a special vote of thanks to the Chairman for presiding. Mr. Worby Beaumont, who was associated with the Royal Automobile Club, had done a great deal to promote the scientific study of motor-headlights.

Among other possible steps with a view to overcoming the dazzle difficulty it seems reasonable to suggest that very powerful beams might be dispensed with in towns, where the street-lighting should be so improved as to render such beams unnecessary. If all sharp transitions from brightness to darkness on roads could be avoided, and the illumination graduated in passing from a main street to a side street or *vice versa*, it would probably be found that very powerful headlights were not required.

Mr. Gaster expressed his appreciation of the paper read by Major Garrard, who had been associated with the tests made for the Ministry of Transport Committee, and had every opportunity of getting to the root of the problem. Naturally the provision of the ideal headlight was not a matter that could be settled in a hurry, and some degree of compromise between apparently conflicting requirements was needed. It would be recalled that the Society had set up a Joint Committee to deal with these problems, and it was hoped, by securing the co-operation of all interested, to obtain useful results.

The CHAIRMAN, in bringing the discussion to a close, said he would like to recall that it was 25 years since he gave in that room the first of a series of Cantor Lectures on Mechanical Road Vehicles. He was laughed at as a visionary with regard to motor vehicles. When he referred to the great business that would henceforth exist for industrial purposes it was thought he ought to be taken away to regain his health. They had to thank the author for bringing this matter forward in such a way as to make them see a good many points which they might not always be ready to consider. All this was only leading to an inquiry from which some regulations with regard to lamps would become possible. The regulations must be such that the police could readily decide whether the light was excessive or such as to be dangerous by dazzling or otherwise cause inconvenience, or whether a vehicle was dangerous, because it could not be seen or could not see a something which was going to be in its way within a certain number of yards or within the power of its brakes. Therefore the first necessity was some simple means of photometry. In the R.A.C. disc they had a very simple means of ascertaining at what distance a thing could be seen by an observer on or about a car, and thus of being able to assess the illuminating power, the distance penetration of any lamp, and to decide upon the questions of too much or of too little power.

Major GARRARD, replying to the discussion, said that he was unable to comply with Dr. Hartridge's request for information regarding the R.A.C. standard anti-dazzle disc, as he knew nothing of the tests to which the disc had been subjected before adoption, nor of the principles followed by the designers.

In reply to Mr. Blok's observations, he did not know whether any lamp did definitely approximate to the polar curve he had shown, but he thought not. In general, the ordinary headlamp did not give sufficient variations of intensity. It was too uniform, and either gave too narrow and penetrating a beam or a wide beam lacking in central penetration. The American experimenters referred to in the paper used a certain pair of headlamps which were calibrated beforehand by means of photometers, voltmeters, etc. The current supplied during the test was measured when required and the beam candlepower thus determined. Both the spherical candlepower and the foot candlepower figures mentioned by him were taken direct from the American paper, and the latter were obviously calculated in accordance with the inverse square law. According to the report of tests by the National Physical Laboratory, referred to in his paper, " A series of measurements on a single beam at distances of 50, 100, 200 and 400 feet on a clear dark

night, showed that the error introduced by the assumption of the inverse square law in reducing illuminations from the observed values . . . . was unlikely to exceed 5 per cent." He agreed with Mr. Blok that it was perhaps undesirable to use the term efficiency, which possessed among engineers a very precise meaning, when some factor of performance was really intended.

In reply to the points raised by Mr. Wilkinson, the diagram showed the beam candlepower at various angles off the axis of the lamp necessary to obtain uniform intensity on a hedge 15 feet from the path of the car until the limit of intensity was reached, when the beam candlepower might remain constant right across the road, that is, for 3 or 4 degrees on each side of the axis. The intensity of illumination was expressed in multiples of the source or rather of the intensity at 45 degrees to the axis. Naturally the conception was a theoretical one, based on the assumption of a certain width of road. Its application in practice depended on how far manufacturers could comply with such requirements. One might imagine a length of road with a wall across it at, for example, 240 or 300 feet ahead of the car, that is, at whatever minimum distance visibility is desired. Across the wall the beam candlepower would be uniform, but on the hedges it could decrease in accordance with the rule given to obtain uniform illumination on the hedges, so that the light available would be utilised with minimum waste.

With reference to Mr. Parnacott's remarks, he was afraid his eyes, although he thought they were normal, would hardly allow him to do more than crawl along with paraffin lamps only, and he thought most people were in a similar position. The consideration that there might be five times the present number of cars on the roads five years hence should influence those who had to decide between a real solution, which he thought could only be obtained by new lamps on new principles, and the attachments to standard present-day lamps, which he thought were only palliatives and would give a comparatively imperfect result. The first lamps he saw which approached the conditions he considered necessary were those designed by Sir Howard Grubb. He did not think either those or the Moonbeam Lamp were all that could be desired, but both went some way in the right direction.

THE MEASUREMENT OF GLAZE ON PAPER.

It is now well recognised that highly polished paper is objectionable, in that it gives rise to direct reflection of light into the eyes of the reader, unless the position of the source is carefully fixed.

It will be recalled that Mr. A. P. Trotter devised an instrument for measuring the degree of specular reflection from qualities of paper, some data on this subject being contained in a Report issued by the British Association in 1915.*

It is interesting to observe that the question is now being considered in Germany. *The Technical Review* refers to several journals connected with the paper-trade in which methods of testing glaze are described. Thus the *Papier Fabrikant* for July 30th contained an account of an instrument devised by Schmidt and Hansch. This consists of a base with a right-angled opening on which the paper is laid, which carries on one side the lighting tube and on the other a polarimeter. Observation through the latter shows a two-compartment field of view. The degree of polish is registered by a scale-indication, corresponding with the position of the nicol-eyepiece giving equal illumination over both portions of the field.

Apparently in Germany reliance is placed on polarisation methods in dealing with this problem. Mr. Trotter's method, on the other hand, depended merely on movement of the lamp used to illuminate the material tested and did not require a polarimeter.

* ILLUM. ENGINEER, Oct., 1915, p. 425.

A NOVEL METHOD OF LIGHTING RAILWAY SUBWAYS.

AN interesting development in the lighting of subways is to be seen at the Charing Cross Underground Station, where the great increase in traffic during the last few years has necessitated the addition of several new passages connecting the Underground and the various Tube railways.

The photograph is taken from the end at which passengers *enter* the subway, and it will be seen that the border of the recesses carrying the lamps are extended somewhat on the nearer side, thus completely screening the filaments from the view of passengers proceeding in the normal direction. In certain minor sub-

By the courtesy of the Underground Electric Railways Company of London, Ltd., we are reproducing a view of the new main subway, taken entirely by the artificial light provided. It will be observed that the lighting is effected by small lamps placed in small recesses in the side-walls, so that there is a clear view down the length of the passage.

ways in the vicinity passengers pass in either direction, and accordingly in this case the borders are extended on both sides of the lamp.

As the photograph suggests, the light is well diffused by the surrounding white walls of the passage, and the method of lighting seems to have distinct advantages for this class of work.

INDEX April, 1921.

REVIEWS OF BOOKS.

Trattato di Fotometria. By A. Coacci (Ulrico Hoepli, Milan, 1920. 249 *pp.* 87 *illus.).*

THIS brief treatise on photometry follows familiar lines, initial chapters being devoted to radiation and fundamental principles, and subsequent sections of the book to standards, photometers, etc. A final chapter deals with the control of fuel for lighting (benzine, acetylene, coal gas, etc.). Speaking generally, the author would appear to be more familiar with developments in Germany than in other countries, most of the photometers illustrated (Lummer Brodhun, Weber, Bechstein, etc.) being German; we notice that the Dibdin illumination photometer is illustrated, while other more widely used British and American instruments are omitted. In dealing with standards of light, again, the author mentions the Carcel lamp and the Violle standard, and explains the Hefner lamp fairly fully, but the pentane standard is apparently not included, and there does not seem to be any reference to the agreement between Great Britain, France and the United States on the international candle.

Journal of the Society of Glass Technology, Vol. V., No. 17, *May,* 1921. *(Published by the Society of Glass Technology, Sheffield University.)*

THIS issue contains a series of interesting papers, including one by C. J. P. Peddle on the "Nomenclature of Glasses." The usual abstracts and reviews of articles dealing with glass technology are also included.

TOPICAL AND INDUSTRIAL SECTION.

[The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona-fide* information relating thereto.]

SIEMENS CELLS AND BATTERIES.

We have received a series of post-war editions of Messrs. Siemens Brothers and Co.'s catalogues of primary cells and batteries, which will doubtless interest readers.

The main catalogue (No. 600) has been considerably enlarged, and contains 88 pages of detailed information. Other catalogues contain mainly extracts from Catalogue No. 600, while No. 531B is specially intended for dealers interested in the more generally employed types of cells, but less familiar with the technical side of the subject.

We understand that attention has been devoted to this branch of work for upwards of 50 years at Woolwich, and the Siemens dry cells in particular have attained a high standard.

SEMI-INDIRECT LIGHTING FITTINGS.

Readers may be interested in the new price list of Semi-Indirect Fittings, recently issued by the British Thomson-Houston Co., Ltd. A great variety of types is illustrated, some of the simple open bowl pendant type, while others, of the ceiling type, utilise a detachable under-bowl under a suitable diffusing over-reflector mounted direct on the ceiling. Incorporated in the leaflet are some illustrations of recent semi-indirect lighting installations. The use of semi-indirect methods in offices, large stores, etc., is of course familiar, but it is interesting to notice that quite a large installation of industrial semi-indirect fittings in an aircraft factory is included.

G.E.C. SPECIALITIES.

From the General Electric Co., Ltd., we receive several recent leaflets dealing with the Osram Gas-filled Lamp, and containing particulars of latest prices, while the latter deals with superlux glassware.

Motorists should be interested in the "Klersite" dynamo for use on motor-vehicles, whereby constant generator-speed (and therefore constant illumination of the lamps lighted therefrom) is maintained, independent of wide variations of engine speed. We understand that this device was exhibited at the G.E.C. stand at the British Industries Fair in February last.

GOOD LIGHTING AS AN AID TO PRODUCTION.

We notice that Benjamin Electric, Ltd., are issuing a series of attractive leaflets, emphasising the benefits of good industrial lighting. Attention is particularly drawn to the claim that "three big profits" are derived from good light, namely, 12 per cent. more production, 25 per cent. less spoilage, and 25 per cent. fewer accidents. Readers are also probably familiar with the new Benjamin Catalogue, dealing largely with industrial lighting, which, besides describing typical lighting fittings, contains some striking photos of installations and useful data on illuminating engineering.

THE ELECTRIC HOME.

The British Electrical Development Association are responsible for a variety of leaflets dealing with electricity in the home. Some attractive examples of lighting are illustrated, while attention is drawn to various other uses of electricity for fires, cooking, hot water, vacuum cleaners, etc.

CARBONISING ILLUSTRATED BY THE CINEMA.

In view of the attention recently drawn in this journal to the varied applications of the cinema for demonstration purposes it is interesting to observe that a film has been recently prepared by West's Gas Improvement Company, illustrating the working of the Glover-West system of continuous carbonisation in vertical retorts. The method is stated to have proved very useful in illustrating the mechanical handling machinery used in this process. Other films illustrate operations in the works at Manchester, where the steel and iron portions of the Glover-West installations are manufactured, and the making of the special silica material near Buxton.

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ELECTRICITY · ACETYLENE · OIL · GAS
ILLUMINATING ENGINEER
Edited by
LEON GASTER

THE JOURNAL OF SCIENTIFIC
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EDITORIAL.

Ship-Lighting in Relation to Safety, Comfort and Efficiency.

To the landsman there is something particularly fascinating about the lighting of ships at sea. On land, the use of artificial light has become a familiar and natural element in civilisation. In this country a town of any size has its public lighting, it is only in sparsely populated, mountainous and barren areas that the surroundings outside one's home are plunged in obscurity. But a ship at sea is an isolated unit, dependent on its own resources for artificial light and frequently moving in the midst of impenetrable darkness.

While the applications of artificial light have been closely studied and actively discussed during recent years, there is surprisingly little information available regarding the lighting of ships. Before the era of electric light, illumination at sea was relatively primitive. To-day an ocean liner, with its own generating station, may have lighting comparable with that on land; as the amount of power required for light commonly forms but a small proportion of the total power generated, there seems no reason to be unduly parsimonious in providing such conditions of illumination as each problem demands.

The discussion opened by Mr. W. J. Jones before the Illuminating Engineering Society on April 26th was a timely contribution to our knowledge of the subject, and the Society was fortunate in having for its Chairman, Mr. Chas. Wordingham, C.B.E., late Chief Electrical Engineer to the Admiralty, who has, naturally, special knowledge of these problems. The introductory paper was necessarily in the nature of a review of existing knowledge, and offers a convenient basis for further investigations. As in the case of so many other discussions before the Society, the co-operation of other experts was felt to be essential, and representatives of the Admiralty, the Royal Navy and the Mercantile Marine Service Association attended and took part in the proceedings.

Certain general considerations in regard to ship-lighting are evident. Of paramount importance is reliability in the lighting, on which the safety of the ship depends. Again, there are special requirements in the form of weather-proof wiring and fittings; the arrangement of lights is limited by restricted overhead space and the fact that fixtures must be rigid and unaffected by the motion of the ship. Lighting problems naturally depend on the purpose served by the ship, *e.g.*, whether a warship, a liner, or a cargo vessel, but in all cases lighting under the deck is surely exceptionally important by reason of the fact that facilities for the admission of daylight are so much more restricted than in buildings on land. Mr. Jones presented a schedule of values of illumination that has been proposed for the American navy, supplemented by actual measurements in various British vessels. We must own that in some instances the values of illumination recorded seem unduly low in comparison with those customary on land, even allowing for the difficulties inherent in ship-lighting. Mr. Jones remarked that little information was available in the form of schedules of illumination for ships of various classes. It would surely be useful to have a definite understanding on this matter, and the Illuminating Engineering Society, in co-operation with officers in the Navy and mercantile marine, shipping companies and others interested, would doubtless be prepared to form a suitable Joint Committee to inquire into such problems.

On a ship, as on land, good lighting is essential in the interests of health, safety, and efficiency of work, and it seems obviously desirable that the conditions of lighting in the hold, the engine room, and other parts of the ship below deck should be as good as possible. Again, in the quarters of officers and crew, adequate illumination plays a most important part in promoting their comfort during intervals of leisure spent below the deck, and facilitating recreation.

The question of providing artificial light on the deck itself is a more debatable one. To the landsman it would seem that work on the moving deck of a ship at night would be assisted by judicious lighting, such as is commonly provided on railway platforms, etc. Shipmasters and officers who spoke in the discussion, however, seemed disinclined to the use of lights on decks of sailing ships, presumably on the ground that any glare from the sources would prove distracting and even dangerous, and that the contrast between the lighted deck and the surrounding darkness would interfere with the look-out. It is possible, however—as in the case of the lighting of the charthouse—that concealed lighting giving a moderate diffused illumination would not have this drawback, and would be beneficial. However, the circumstances here are exceptional, and the problem would certainly require careful study and experiment before definite recommendations could be made.

The Cost of Publication of Scientific Researches.

A few months ago we referred to the experiences of many scientific societies in regard to the publication of researches. As is well known, the cost of printing has greatly advanced beyond pre-war figures. On the other hand, the amount of matter deserving of publication is now exceptionally great, many researches held up during the war being only now completed ; moreover, interest in scientific investigation has been stimulated and there are probably more experimenters at work than in pre-war days.

The greater output of scientific papers and researches is a healthy sign, for industry is largely dependent on scientific research. Economic conditions at the present time are exceptionally difficult, and industries depending mainly on cheap production may be faced by serious problems for some time to come. Scientific research is a potent aid to cheap production, but it is more than this. Inventions and discoveries may form the basis of entirely new processes and new industries, the value of which may be so great that for some time cheap production takes a secondary place. Valuable novelties and great inventions are among the greatest commercial assets a nation can possess.

Progress of this nature is ultimately dependent on the dissemination of scientific knowledge. Hence the fact that many scientific bodies find extreme difficulty in maintaining the pre-war facilities for publication—quite apart from extension—is undoubtedly a serious handicap to scientific advance in this country. The question is referred to in the Fourth Report of the Conjoint Board of Scientific Societies, which has formed a Committee to present a case for the consideration of the Government with a view to obtaining grants in aid of publications by various societies. Eighteen out of 56 societies approached have expressed a desire to be included in the application. Naturally, at the present time, bodies are reluctant to ask for assistance except where it is urgently needed, and we have reason to believe that the amount suggested is comparatively small. It would, however, small as it is, make a great difference to the position of scientific publications, and we certainly hope that the Committee will be successful in their efforts.

Another matter of moment to scientific societies is the increased postage incurred in distributing their publications. Even before the war, scientific bodies, publishing their transactions at monthly or longer intervals, were at a disadvantage in comparison with daily and weekly newspapers and journals who enjoy special postal rates. The increases since made by the Post Office have accentuated this difficulty, which has been brought to the notice of the Board by several of the societies approached. We certainly think that in this direction also some concession might be made by the Government. It seems probable that, from the national standpoint, the loss of revenue, if any, would be trivial—especially as lower postal rates would encourage greater freedom of distribution. Moreover, a Government which has sanctioned greatly increased national expenditure on education should surely recognise the duty of encouraging the valuable educational work being done through private means by the various scientific societies.

International Co-operation in Scientific Research.

In commenting, in a recent issue, on the formation of the International Students' Union, we remarked that one of the unfortunate consequences of the war had been the interruption of regular exchange of views between scientific men in various countries. By the exchange of journals and publications we are now learning something of developments in foreign countries, but it is only gradually that international congresses and other facilities for the joint discussion of scientific problems are being resumed.

A gratifying feature in the field of illuminating engineering has been the announcement of the session of the International Illumination Commission, to be held in Paris during July 4th–7th, at which a number of interesting subjects will be discussed. The Commission is linked with national illumination committees in various countries, some of which have now resumed active work, while others will doubtless be formed in the near future.

We are also interested to observe that the Conjoint Board of Scientific Societies has requested the Executive Committee to take steps to inquire into the question of forming international unions for specific fields of research, under the auspices of the International Research Council. Committees have already been nominated to deal with proposed unions of Mathematics, Physics, Scientific Radio-Telegraphy, Geology, Geography, and Biological Sciences. It is interesting to note that the Committee on Biology has adopted a resolution to the effect that it regards the restoration of normal conditions of scientific inter-communication with Austria and Germany as an indispensable preliminary to the formation of a Biological Union.

As an illustration of interesting developments abroad, we may refer to the formation, in March last, of a second Illuminating Engineering Society in Germany, viz., the Lichttechnische Gesellschaft, with headquarters at Karlsruhe. The activities of this body will be supplementary to that of the other existing Society (the Beleuchtungstechnische Gesellschaft), as it will serve the south-western areas. The headquarters are conveniently situated, as there is already in existence an Institute for Illumination and Optics (Lichttechnisches Institut) with a suitable laboratory at the Technische Hochshule.

This development should surely serve as a hint to this country. There are in the United Kingdom a number of universities and technical institutes where the professors take an interest in illuminating engineering and carry out as much work as circumstances allow; but the facilities for research in this field are naturally less than they would be in a specially constituted Institute for Optics and Illuminating Engineering. We note with interest that the Committee on National Instruction on Technical Optics operating under the Conjoint Board of Scientific Societies, has recommended the Board to support the scheme submitted for buildings and equipment for the Optical Department of the Imperial College of Science and Technology, a provision having been made by the Governing Body for a suitable site. We sincerely hope that in the programme of the Imperial College facilities for research in illuminating engineering and the photometric testing of lamps and lighting appliances will be included. If a section of the proposed building could be devoted to this subject it would meet a recognised need in this country.

L. Gaster.

TRANSACTIONS

OF

The Illuminating Engineering Society

(Founded in London, 1909.)

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

SHIP-LIGHTING IN RELATION TO SAFETY, COMFORT AND EFFICIENCY.

(Proceedings at a meeting of the Society held at the House of the Royal Society of Arts, 18, John Street, Adelphi, W.C., at 8 p.m., on Tuesday, April 26th, 1921.)

A MEETING of the Society was held at the House of the Royal Society of Arts at 8 p.m., on Tuesday, April 26th, Mr. C. H. WORDINGHAM, C.B.E., presiding. The minutes of the last meeting having been taken as read, the HON. SECRETARY announced the names of the following applicants for membership :—

Mr. Chas. Allsopp	Assistant, Bradford Corporation Elec. Supply, Town Hall, Bradford.
Mr. E. Leachman	British Illuminated Sign Co., Ltd., 27, Heddon Street, Regent Street, W.1.
Mr. A. P. Mackie	Engineer-in-Charge, City Corporation Test Room, Dunedin, New Zealand.
Mr. F. Twyman	Messrs. Adam Hilger, Ltd., 75a, Camden Road, London, N.W.1.

In opening the discussion the Chairman remarked that this was a subject on which the co-operation of those in the Navy and Mercantile Marine was naturally welcome, and it was therefore gratifying to note that representatives of the Admiralty, the Royal Navy and the Mercantile Marine Service Association had kindly arranged to be present and join in the discussion.

THE CHAIRMAN then called upon Mr. W. J. JONES to read his paper on **"Ship-Lighting in Relation to Safety, Comfort and Efficiency."** In the ensuing discussion Mr. F. P. FLETCHER (Elec. Eng. Dept., Admiralty), Mr. S. H. CALLOW, Capt. COLIN NICHOLSON (Mercantile Marine Service Association), Mr. J. W. ELLIOTT, Lt.-Com. J. W. A. WALLER, R.N., Capt. COLLIER, Mr. P. J. WALDRAM, Capt. A. I. TAYLOR, Mr. C. L. MATTHEWS, Mr. C. E. GREENSLADE, Mr. FREETH, Mr. A. M. CURRIE, The CHAIRMAN and Mr. L. GASTER took part.

Mr. JONES, in reply, referred briefly to various points dealt with in the discussion, and stated that he would deal with these more fully in the printed account of the proceedings. A vote of thanks to the author was passed unanimously, after which THE CHAIRMAN announced that the **Annual Meeting** would be held at 7.45 p.m. on **Tuesday, May 31st.**

SHIP-LIGHTING IN RELATION TO SAFETY, COMFORT AND EFFICIENCY.

By W. J. Jones, B.Sc. Eng.

Introduction.

The lighting of ships is a matter which has commanded an increasing amount of attention during the last few years, but, at present, there is but little literature available upon the subject. It is obviously one that has many aspects because of the great variety of purposes for which the ships are built and the enormous differences in their dimensions.

In the case of large vessels the amount of energy required for lighting forms only a small fraction of the total energy developed (rarely more than 1 to 2 per cent.), and in these cases there seems to be no need for parsimony in providing the light that is needed. In the case, however, of smaller vessels, the possibilities of supply become more limited, and here the lighting is necessarily more primitive.

The demand and quality of lighting that is required on a liner—which is practically a large floating hotel—obviously differs from that required in cargo vessels, but it is now convenient to light by electricity even the smaller sized vessels.

A liner with its own electric supply available for lighting, requires light for many purposes, and all the arts of illumination are required. Generally speaking all the advantages of modern land lighting can be incorporated in the lighting of a vessel with but few modifications: a ship has, however, the advantage that the area to be illuminated is relatively small, so that the cost of distribution is not so important and the voltage may be selected largely with a view to the convenience and efficiency of the lamps used. Since the introduction of electricity on board ships there has been a marked improvement in the amount of illumination provided. The lighting of the working parts of the ship appears to offer the greatest room for improvement.

It is interesting to note that the S.S. "Columbia," built in 1879, was sent to New York to be fitted with the first Edison Incandescent Lighting Plant; the lampholders consisted of small spiral springs of wire and the lamps, which had carbon filaments, were fitted with small loops for hanging to these little springs. The first ship of the British Navy to be fitted with electric light was H.M.S. "Polyphemus" in about 1882 or 1883, and shortly afterwards H.M.S. "Edinburgh," "Collingwood," "Rodney," "Imperieuse" and "Warspite" were similarly fitted. In those days the carbon filament lamps showed such a marked improvement over the former methods of lighting that electric means of illumination were rapidly adopted in all of the important vessels, and we now find that almost all ships have an electrical equipment. Apart from the improved illumination, electrical lighting has been found to be safer, so much so that the premium charged by Lloyds for electrical illuminated ships is considerably lower than for those hulls which are still depending on oil lamps. From the hygienic standpoint, too, the introduction of electricity on boats has much to commend it, since electric lamps, being completely enclosed, cannot vitiate the atmosphere nor contaminate foodstuffs. The importance of this is realised when one remembers the limited amount of space available on board ship and the consequently crowded conditions which must of a necessity prevail.

Hitherto the lighting of ships does not seem to have been treated in the same systematic way as problems of interior illumination on land. Inspection of a number of specifications shows that it is usual to allot a certain number of lighting points for a given area; and it is seldom that the method of illumination and the position of the light sources are defined, these matters often being left to the discretion of the contractor. The nearest approach to a definition of the amount of light required that I have observed, in boats of English origin,

is taken from a specification of one for French service. In this case the amount of light needed in one or two of the important rooms was specified to be between four and five "decimal bougies" per square metre of ceiling, which works out to be approximately 0·04 to 0·05 candlepower per square foot of ceiling—a value which seems extraordinarily low.

One who refers to the literature on the subject will be surprised by the slight amount of information which is available. A hunt through the Technical Libraries will show that only one or two books have been written on the subject, and the number of references on ship lighting in notebooks is strictly limited. In about 1892 two books were written upon the subject, one by S. F. Walker and the other by J. W. Urquhart, upon the introduction of electric lighting into ships, but these works chiefly deal with the wiring and such electrical apparatus as was known in those days.

Electrical Plant and Wiring.

The wiring of ships is a matter of paramount importance in view of the fact that escape from a ship at sea is always accompanied by considerable danger, and, therefore, it is essential that the risk from fire from electrical defects be reduced to a minimum by the use of suitable fittings and wiring. Special attention has been given to the choice of material of the best and highest quality. The rules issued by the Institution of Electrical Engineers on ship lighting embody the most recent information and modern practice to ensure safety. One of the most important matters is to ensure that in passenger vessels there are spare generators to serve in case of breakdown. At first it may seem a great waste, or extravagant to have the electrical generating plant split up into a number of units, but the thermal efficiency of the small engines at full load is much greater than large ones that are under-run.

Below is shown the sub-division of the generating plant on one or two vessels, and also the voltage of the system employed :—

"Britannic" and "Olympic" (White Star Line). Four-400 k.w. 3-crank comp. engine, 325 r.p.m., 100-volt.

"Aquitania" (Cunard S.S. Co.). Four 400 k.w. Turbogenerators, 1,500 r.p.m., 220-volt, 3-wire system.

"Mauretania" (Cunard S.S. Co.). Four 375 k.w. Turbogenerators, 1,200 r.p.m., 110-volt.

"Alsatian" and "Calgarian" (Allan S.S. Co.). Three 250 k.w. Turbogenerators, 3,000 r.p.m., 220-volt, 3-wire.

"Missanabic" and "Metagama" (Canadian Pacific R. Co.). Three 100 k.w. 100-volt.

"Camito" and "Coyonada" (Elders and Fyffes). Three 90 k.w. 2-crank comp. 450 r.p.m., 100-volts.

"Eloby" and "Elele" (Elder, Dempster). Two 20 k.w. single cylinder. 600 r.p.m., 100-volts.

The main generators are usually capable of supplying the full normal requirements of the ship with one out of commission. This arrangement allows repairs or adjustments to be made and still preserve the continuity of the supply.

In most vessels it is usual to have an emergency plant, sometimes driven with an oil engine, placed well above the water line, in the event of the boiler room being flooded, and this set supplies emergency lighting for the ship. On some others, accumulators are installed on one of the upper decks to serve the same purpose. All precautions should be taken to ensure that the electric lighting system is perfectly reliable, and any alternative system must provide that so far as possible the ship is never without a light. Particularly is this important in the case of accidents, to enable boats to be lowered, and to assist in picking up persons from the water.

Provision must be made so that the magnetic field of electrical machinery has a negligible effect upon the compass needle, and for this reason electro-magnetic gear is disposed well away from the compass bowl. Cables, too, must be kept well away from the vicinity of the compass, and it is recommended that cables carrying continuous current be not nearer than 30 feet. In order that the lead and return currents shall neutralise one another in two conductor systems, conductors in the proximity of the compass shall preferably be twin. Conductors within the compass binnacle shall be short and direct as possible, and if separate they shall be twisted together and shall not be coiled into

spiral loops. Incandescent lamps for illuminating the compass card shall not consume more than 0·6 ampere, and be so placed that no live parts are at a less distance than seven inches from any part of the magnetic system of the compass.

The wiring of ships' rooms is dealt with in one or two publications, including those of Walker and Urquhart as mentioned previously, and more particularly in a pocket book by T. M. Johnson. These and more recent papers describe methods of distribution of electrical energy in the ship and it is interesting to note that the ring method of distribution is becoming more and more in favour.

The great advancement that has taken place in the amount of ship lighting can be gathered from the following particulars made out for S.S. "Majestic" some 30 years ago, in which it will be noted that the total number of lamps was 1,200, whereas in a modern liner the number of lamps called for often exceeds 10,000 or 12,000.

The following schedule is also interesting as it shows a method of arranging the lighting circuits on board ship :—

"Majestic." 1,200 16 c.p. carbon lamps, for masthead, side lights, compass or binnacle lights, telegraph lights, cargo lanterns and exterior deck lighting.

Schedule gives only half of the installation.

No. 1 Circuit. Main Deck.

Starboard Half Saloon	27
First Class State Rooms, and Stewardess' Lavatory and Bath	29
Starboard Half Library	13
Saloon Dome	32
Starboard Half Steerage and Forecastle	6
Forecastle Stores	1
Starboard Half of Library Lamp ..	3
Total	112

No. 2 Circuit. Upper Deck.

Upper Whale Back and Emigrants' Smoke Room..	22
Upper Deck State Rooms, forward, lettered I to T	22
Upper Deck State Rooms, midship, lettered, E, F, G, H, V, W, Y ..	9
Passages on Upper Deck..	14
Barber Shop	2
Bath Room	1
Total	70

No. 3 Circuit. Hurricane Deck.

Two Cargo Lanterns	20
Officers' Quarters	14
Chart Room, etc.	19
Port Half Library	13
Upper Deck Promenade	12
Upper Deck State Rooms, A, B, C, D	6
Passages leading to above	4
Lights on Stairway of Saloon	6
Dome Light on Main Stairway	4
Lounge at end of Library, Port	3
Portable Lamp in Wheel House	2
Hurricane Deck, Pantry	1
Forward, Upper Fans and Stairways to Boiler	5
Total	190

No. 4. Circuit. Main Deck.

Second Class Smoke Rooms	6
Port Half Second Class Saloon ..	4
Second Class Pantry and Passages ..	9
Steering Gear	9
Steerage Lavatory	14
Telegraph Aft	11
Mid-Deck and Steerage Aft	11
Cargo Lantern Aft	11
Emigrants' Galley	3
Total	69

No. 5 Circuit. Spare.

No. 6 Circuit. Starboard Engine Room.

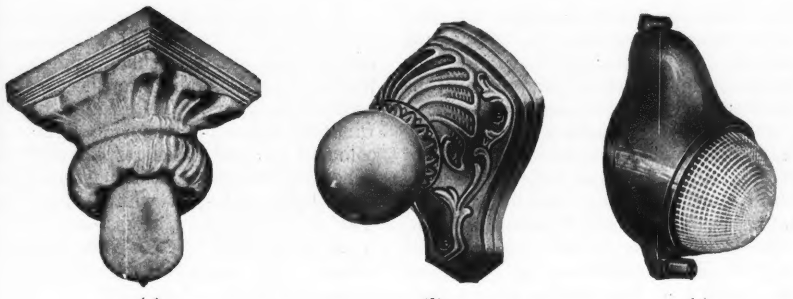
Tunnel	6
Lower Platform	20
Mid Platform	32
Top Platform	4
Portable Lamps	3
Stores	3
Gauge Glass Lights	14
Portable Lamps	7
Fan Brass Lights..	8
Stoke Hole Tunnel	2
Portable Lamps over Boilers	12
Fireman's Stairway	3
Total	106

Note.—At no time should any dynamo exceed 400 lamps at 100 volts.

Fittings.

The electric lighting fittings used on board ship must be of a strong and substantial design, and sufficiently rigid to withstand the motion of the vessel. On account, however, of the low head room that is available, they must necessarily be short. Fittings may be classified into three distinct types :—

(1) Special ornamental or decorative fittings for first class state rooms and saloons. Figs. 1 (*a*)—1 (*c*) show a number



(a) (b) (c)

Fig. 1.—Typical majolica fittings.

of small ceiling, wall, and berthlight fittings which are in common use on most boats. These majolica fittings consist chiefly of a shell of cream porcelain which covers the lampholder. Frosted lamps are most frequently used in conjunction with these fittings.

For state rooms the berthlights shown are provided with Holophane bowls which focus the light to the position required, eliminating the possibility of disturbing the occupants of other berths with stray light.

(2) Plain brackets and pendants for the passage ways and third class rooms, in which utility is required rather than ornate appearance.

(3) Watertight fittings, such as well glass and bulkheads, for the engine room, decks and other exposed parts of the vessel.

The I.E.E. Regulations specify that these last shall be so constructed as to withstand an emersion under a 3-foot head of water before fixing, and after erection they shall be capable of standing the application of a stream of water ejected from the open end of an ordinary wash-deck hose, under a head of 15 feet, for a period of 15 seconds, the outlet of the hose being six feet away from the fitting. In spaces where goods are liable to be stacked in close proximity to the fittings, it is usual to provide them with substantial metal guards for protecting the globe from mechanical injury.

It is unfortunate, however, that although the quality of the wiring and electrical fittings are carefully specified, there is no information available concerning the intensity of illumination that is required in various parts of the ship.

Board of Trade Regulations.

The only regulations that have come to the notice of the author are included in the "Board of Trade Regulations," in which it is specified that "foreign and home trade steamers are to be properly lighted and ventilated day and night, with proper means of access, wherever

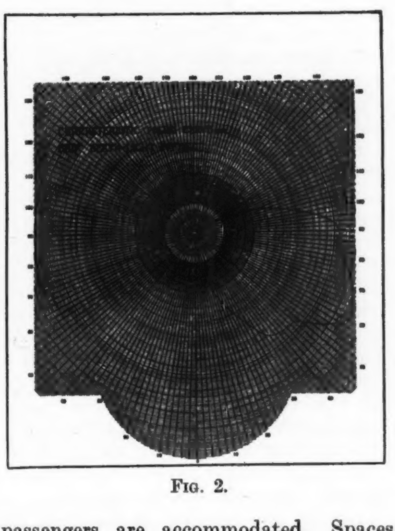


Fig. 2.

passengers are accommodated. Spaces not naturally lighted must be lighted electrically, and not by lamps."

Regulations for Emigrant Ships' Lighting.

In regard to the lighting of emigrant ships it is further specified that: "Good natural lighting to be provided in all steerage spaces. Side lights to be at least

9 in. diameter; to have brass or gun-metal frames, and to be fitted with dead lights. When electricity is the sole means of lighting the generators must be situated well above the waterline."

It will be seen that these do not in any way specify what is considered adequate illumination. It is not sufficient to have lamps of a certain candlepower or intensity. This Society is essentially concerned with the ability to visualise objects clearly which depends rather on the amount of illumination falling upon the working plane, than upon the quantity of illumination emanating from the light source.

Lighting Requirements for Special Positions.

Board of Trade Lights. For the purpose of steering the Board of Trade specify that there shall be navigation lights from the foremast head, mainmast head, and that there be provided port and starboard side lights, and a stern light. The question of the visibility of such lights when seen at a distance is naturally of very great importance, and has been the subject of research at the National Physical Laboratory during recent years. The lamps for the masthead, stern light, and side lanterns are specified to consist of 32 candlepower carbon filament lamps, having two filaments each of 16 candlepower operating in parallel; the reason being that should one filament fail it is a very remote chance that the other will go out of commission at the same time. These lamps are usually subjected to a close inspection once every half-hour, but it is usually difficult, and at times impossible to see from the bridge of the vessel whether the navigation lights are burning satisfactorily, and as it is important that the failure of any one of the lights should be immediately known by the officer in charge, some form of indicator is therefore necessary in the wheelhouse or chartroom in order to give this information. Such an indicator is shown in Fig. 3, and it shows by means of luminous indications when the lamps are burning satisfactorily, and also is designed to give an audible signal when they fail and a visual warning when one of the filaments of double-filament lamps breaks.

On the front of the indicator is shown a deck plan of the ship in white enamel and having small circular windows in positions corresponding to those of the navigation lights. The glasses of the windows indicating the side lights are coloured red and green respectively, the windows indicating the masthead and stern lights being of white glass. The teak case, to which access is obtained by a door fitted with a lock and key, contains switches which will control the navigation lights. Each switch is clearly labelled. As long as the navigation lights are burning satisfactorily the windows of the indicator are illuminated from the inside by small indicating lamps, each window having its own lamp. The indicating lamps are not directly in series with the navigation lamps, but are connected in parallel with coils which are in circuit with the navigation lights; and failure of the indicating lamp, therefore, does not interrupt the circuit of the navigation lamp. The coils in the circuit of the navigation lamps act as relays and they control the circuit to a watertight bell mounted on the top of the case.

In the event of any of the navigation lights failing, the indicating lamp corresponding to that particular light is extinguished immediately. At the same time the armature of the series coil mentioned above falls away, and, in doing so, completes the circuit of the bell, which commences to ring, this giving audible warning of the failure of the navigation light. The bell continues to ring until the switch controlling the particular circuit is opened.

In the case of navigation lamps having double-filaments, when both filaments are intact the indicating lamp burns with its full brightness. If one filament breaks the indicating lamp continues to burn, but with diminished brightness, and the bell does not ring. If the second filament should then break the indicating lamp is extinguished immediately and the bell will ring.

The lighting of compass-dials, charts, etc., also presents special problems. Naturally, the lighting should be of the concealed character, the actual sources being screened from view. In some arrangements the illumination is effected

from lamps boxed in underneath the charts which are held stiff between sheets of glass. The device may also be equipped with a wind-screen enabling the charts to be examined in comfort.

Searchlights.

The advancements that have been made in the production and operation of searchlights are many, and have been recently described in the proceedings of this Society and in the proceedings of the Institution of Electrical Engineers, and, in view of this it is not thought necessary to dilate upon this matter further. The possible applications of searchlights in the mercantile marine, in addition to their familiar uses on war vessels, deserve attention. It has been suggested that they would sometimes be of value in locating icebergs or approaching vessels, and, in the event of an accident, for illuminating the sea and assisting boats in picking up floating survivors.

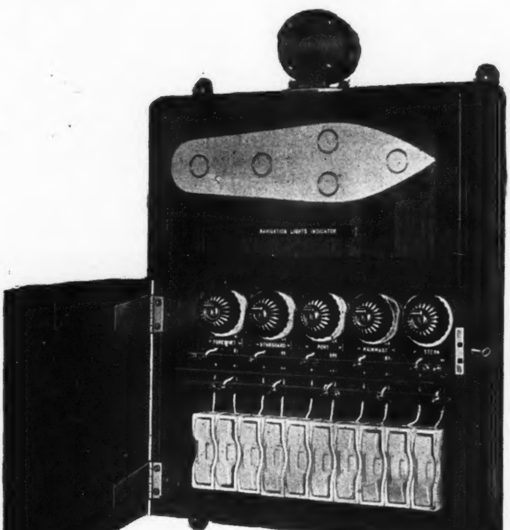


FIG. 3.—Showing ship navigation lights indicator.

Signalling.

This, too, is a subject which has been very amply dealt with of recent years and forms a means of communication between different parts of the ship and also for communicating between vessels at sea. The internal communication lighting signals consist of numerous circuits for conveying a definite message by illuminating a glass or other translucent dial on which the message is shown. Distance signalling is accomplished principally by the Ardois light, semaphore light, blinker light and the searchlight. Description of these systems is also outside the scope of this paper. Distress signals, etc., may also be given by burning flares, and in view of the progress made with such devices during the War it is possible that the conventional lights of this description might now be improved upon. While, earlier in the paper, the advantages of electric lighting for the general lighting of ships have been emphasised, the value of emergency portable lights, such as could be used in the event of the generating system being put out of action, should not be overlooked. Such supplementary means of lighting might also be most valuable to shipwrecked parties in boats, and their possibilities as a regular element in safety appliances deserve attention.

Lighting of Passenger Vessels.

The lighting of passenger vessels differs in some measure according to the work for which the ship is commissioned to do, and Mr. L. C. Porter, in the Transactions of the Illuminating Engineering Society of America, 1912, divides passenger vessels into three classes :—

(1) Ferry boats which make but short journeys.
(2) Coastal steamers.
(3) Transatlantic liners.

Below are given figures from his report, which represent the average obtained on a number of vessels representative of the above classes :—

Ferry Boats.

Lower Cabins ..	1·8 foot-candles.
Upper Cabins ..	1·6 foot-candles.
Promenade Deck ..	No exterior lighting.

In this country it is usual to have a few exterior lights and often to provide cargo clusters to illuminate gangways.

River, Lake, and Coastwise Steamers.

Social Halls	2·4 av.
Dining Rooms	0·9 av.
Smoking Rooms	1·6 av.
Passage ways (white enamelled) 25 watt lamps 10 ft. apart ..	0·9 av.
State Rooms (white interior)	0·6 av.

Transatlantic Liners for Several Companies.

Drawing Room	1·50
Dining Room (First Class, with use of Table lights)	3·40
Smoking Room	1·80
Writing Room	4·20
Gymnasium	1·40
Dining Room (Second Class, with use of Table lights)	2·5
Drawing Room	1·4
Smoking Room	1·6
Dining Room (Third Class)	0·6
Smoking Room	0·4

[T.I.E.S., April 1912, No. 4, Vol. VII.]

Below are given some readings which have recently been taken on the White Star Liner "Olympic."

Passengers' Quarters, First Class.
Foot-Candle Intensities.

First Class Companionway ..	2·0 —3·0
First Class Alleyway (white) ..	0·45—0·55
First Class State Rooms (local lights) ..	1·6
Three 30-watt Frosted, 8′ 6″ high. Period decorations.	
First Class Reception Room	2·2
First Class Dining Room	2·5
Ceiling Fittings, 5-light every 8 ft.	
Bath Room	1·2
Lavatory	0·7
Maids' and Valets' Saloon (Units between Girders)	1·8
Smoking Room	2·0
Swimming Bath (Frosted lamps every 4 ft. 6 in. over edge of bath) ..	0·5
B. Saloon Café	3·5
B. Deck (Bulkheads)	0·5

The first class companionway, the reception room and the dining room were provided with ceiling fittings with translucent glass, each having five lights, the units being at distances of approximately eight feet from one another. The fittings are so designed as to be in keeping with the artistic features of these compartments and, although the lighting obtained was not especially high, the result was distinctly pleasing and comfortable. The first class state rooms are provided with lights for general illumination and with local lights over the berths, and a number of these rooms had period decorations ; in these instances, the lighting is such as to harmonise with the general design of the room. The maids' and valets' saloon calls for special attention in view of the fact that on looking into the room very little of the sources of light can be observed, as the units consisting of 30-watt frosted vacuum lamps have been placed between alternate cross girders.

Passengers' Quarters—Second Class.

Second Class Companionway	2·7
Second Class Dining Saloon	2·2
Single cut pines, 6 ft.—8 ft. apart.	
Second Class Cabins D Deck ..	0·5—0·6
Second Class Library	4·0
Unit between beams spaced 3 ft. by 8 ft., 8 ft. high.	
Second Class Alleyway	0·7
Second Class Smoking Room	2·0

The second class part of the ship was as a whole well illuminated, but not quite so ornamental, but the cabins had a rather low general illumination of 0·5—0·6 foot-candles and local lighting for berths was not provided.

Passengers' Quarters. Third Class.

Third Class Companionway	0·7
Third Class Cabins	0·5—0·6
Dining Saloon	2·0
Smoking Room	2·0

In the third class quarters the fittings were more useful than ornate, and the cabins themselves were only illuminated

with 0·5—0·6 foot-candles. It is to be noticed, however, that in all three parts of the boat, the corridors had an illumination of approximately 0·5 foot-candles, and, in view of the fact that the whole of the corridors were done out in white enamel, a pleasing and satisfactory result is obtained.

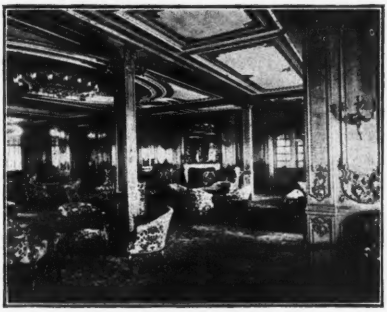
Boiler Room (Oil Fuel).

Steps to Boiler Room from Engine Room (dark)	0·2
General Lighting Stokehold	0·25
Local lights on gauges and in bilges.	
Pump Room (gas-filled lamps, 500 watt)	4·0

Turbine Room.

General Lighting	0·4

(*a*) Typical Saloon Lighting with distributed single units.



(*b*) Chandelier lighting from below central dome. Limited overhead space makes it necessary to use a very short and rigid chandelier.

(*c*) General lighting by ceiling cluster units containing several lamps within diffusing lantern. A pleasing effect is also produced from strip light fittings outside amber window panes on right, giving the impression of sunlight.

(*d*) Distributed lighting with 3-unit ceiling fittings.

FIG. 4.—Typical Saloon Lighting.

Engine Room, Boiler Room, etc.

Engine Room.

Tops (30-watt units in well glass fittings spaced approx. 8 ft. apart)	1·8
Steps	1·8
Middles (with two 1,000-watt G.F. lamps over top of wells)	1·2
Starting Platform	1·8
Bottom Platform (Port Feed-pumps)	0·5
Bottom Platform (Starboard and Sanitary Pumps)	0·3

Dynamo Room.

General Lighting	0·4
Switchboard Platform	1·4
Back Switchboard Platform	1·4
Tunnels	0·25
Light over almost each bearing.	

The parts of the ship containing moving machinery are conspicuous by the fact that the walls are finished in white, and

the result is that the engine room is much more congenial for working in than it would otherwise be. The height of the engine room itself allows the use of two 1,000-watt gas-filled lamps in focusing type reflectors, and these lamps considerably help to produce a superior illumination. These high candlepower lamps are mounted above the tops of the engines over a comparatively clear space. Fig. 5 shows the amount of light that is obtained from above from this source, although the source in this instance was probably 25 feet above the machinery. It will be observed that steam pipes with their white lagging also help to diffuse the light.

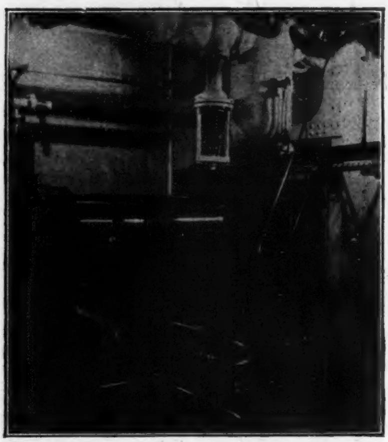


FIG. 5.—Showing effect of overhead light in engine room.

Boiler Room (Oil Fuel).

The boiler room naturally presents a rather gloomy appearance because of the black boilers themselves. In the case of the oil boilers on board the "Olympic" it has been found advisable to white enamel the bilges below each boiler and place one or two lamps in them. This is in order to permit the immediate detection of leakage of oil and thus help to minimise any risk of an explosion due to such leaks. The pumps which provide the boilers with fuel are lighted from above by 500-watt gas-filled lamps and here again no better light can be desired. (See Fig. 6.)

Tunnels.

The tunnels in the case of this boat are finished exclusively in white, and, although the general illumination throughout is only of the order of 0·25 foot-candles, visibility is perfect. This, of course, is important, in view of the fact that it is necessary to continually inspect the bearings and thrust blocks, and the full effect of the rolling and pitching is obtained in these parts.

Throughout all the above rooms, there is ample provision of plugs and sockets in order that local lights can be obtained for any repair work, or temporary lighting.

FIG. 6.—Showing advantage, in reflection of light, obtained from white painted steam pipes in boiler room.

Working Parts of Ship.

Bakery (Third Class)	0·58
Ovens	0·40
Alleyway (working)	0·20
Lavatory	0·30
Bath Room (Stewards)	0·30
Bath Room (Stewards)	0·60
Bunks (Stewards)	0·30
Chief Electrician's Room	0·6
Officers' Quarters	0·6
Electricians' Shop (with local lights)	1·0
Ice Plant	0·5—1·0
Blower Room	0·5

The working parts are generally adequately illuminated because of the light surroundings and, in the case of the workshops, there are always provided

local lights. An instance of adequate illumination, but of low intensity, is found in the working alleyway where the intensity is only 0·20 foot-candles; but, because of the high reflecting and diffusing character of the walls, it is sufficient.

All the above readings were taken three feet above the ground except those in a few cases taken on the level of the ground. In all cases they represent the minimum values.

Illumination in the Navy.

From inquiries that have been made there does not appear to be any specification of foot-candle intensities in various parts of a ship in the Navy of this country, but below is a schedule giving the foot-candle intensities which represent the ideal table of intensities of illumination which should be obtained in the various compartments and spaces in vessels of the American Navy. These figures are taken from a contribution to the Transactions of the Illuminating and Engineering Society of America by Lieut. C. S. McDowell. This table resulted from a special investigation on the subject by the Navy Department of U.S.A. in 1913, when it was realised that good illumination enabled the work to be more expeditiously carried out, and a greater degree of proficiency obtained.

Foot-Candle Intensities.

Ammunition passages	2·0
Armoury, plus metal reflectors at bench	2·0
Battle Dressing Station	2·0
Battle Dressing Stores	2·0
Bakery	2·0
Bath Room	2·0
Barber's Shop	2·5
Boiler Rooms, plus 250-watt units	1·5
Butchers' Shop	1·5
Band Room	1·0
Blower Room (special)	—
Blower Space	1·0
Cabins	3·0
Carpenters' Shop	3·0
Chart House	5·0
Chief P.O. Quarters (berthing)	1·5
Chief P.O. Quarters (messing)	2·0
Crew's Space	1·5
Country (officers')	1·5
Crew's Wash Room	2·0
Crew's Water Closets	2·0
Conning Tower (special)	—
Chain Locker	1·5
Coal Bunkers	0·7
Coaling Ship (special)	—
Dispensary	3·0
Desk	4·0
Distribution Room	2·0
Dynamo Room, plus 250-watt units	1·5
Decks, outside (special)	—
Engine Room, plus 250-watt units (treated special)	1·5
Evaporator Room	1·5
Firemen's Wash Room	2·0
Foundry	3·0
Fire Room (treated special)	—
Fuel Oil Relay Tank Room	2·0
General Condiment and Issuing Room	2·0
General Mess Pantry	2·0
Galleys	2·0
Handling Room	2·5
Interior Com. Room	2·0
Ice Machine Room	2·0
Isolation Room	2·0
Issuing and Store Room	2·0
Laundry	1·5
Lamp Room	1·5
Machine Shop (General)	1·0
Magazine	1·5
Mess Rooms (Officers')	2·5
Mess Attendants' Wash Room	2·0
Offices	4·0
Operating Table	15·0—25·0
Paint Room	1·5
Paint Mixing Room	1·5
Pantries	2·0
Printing Office	4·0
Pump Room	1·5
Post Office	4·0
Prison (special)	—
Reception Room	3·0
Surgeon's Examining Room	2·0
State Rooms	3·0
Sub	4·0
Sub Central	4·0
Shell Room	2·0
Store Rooms (Fixed Stores)	0·7
Store Room (Stock for Issue)	1·0
Sick Bay	2·0
Storage Battery Charging Station	2·0
Ship's Store	2·0
Torpedo Room	2·0
Turrets (special)	—
Water Closets	1·0
Wireless Room	3·5
Workshop (additional special illumination to be provided at machines)	1·5
Windlass Space	1·5

Conclusions.

A consideration of the figures quoted from the above authorities and from those which I have recently taken lead to the following conclusions:—

Saloons.

The decorative element of lighting is predominant in saloons, and the fixtures may be of almost any design, usually in keeping with the design of the compartment. It is, however, necessary to particularly avoid glare and hard

shadows. An intensity of 2—3 foot-candles is suggested as being adequate for this purpose. It is, however, almost impossible to employ high candlepower units because of the small head room, and this almost invariably means the use of a number of small units to obtain an even illumination.

Writing Room or Library.

There are apparently two general ways of illuminating these rooms: (1) by a general illumination of 1—2 foot-candle intensity, supplemented by table lamps or sconces; (2) by a much higher general illumination, which is so designed as to be thoroughly diffused, having a value of 4 foot-candles.

Dining Room.

Here, again, there are two methods of lighting: (1) by means of a general illumination, supplemented by table lamps; (2) by a higher general illumination. A foot-candle intensity of 2—3 foot-candles is suggested.

Engine Room.

It is usually somewhat difficult to illuminate adequately such spaces on account of the multiplicity of overhead pipes, girders, ladders, etc., but, by making the surroundings light, and, if at all possible, white, a vast improvement is obtained. In the first place it is usual to instal well glass fittings with 30-watt lamps, but, if these are used in very dark surroundings, the effect of glare is apparent. It is accordingly put forward as a suggestion that the engine rooms be lighted as far as possible with fittings provided with some means of obscuring the source of the light, and this may be done by the expedient of shades or opalescent globes. The effect of shades was particularly noticeable in the engine room of the "Port Adelaide." It is important that all gauges and indicators be provided with local lights which have the source of light obscured from the eyes. Provision of good lighting, and by that is imputed that it be sufficient in intensity and properly screened, is necessary as manipulations have to be made to machinery while it is in motion.

Boiler Room.

This is probably the most difficult part to illuminate of all, in view of the dead black exteriors of the boilers and the consequent lack of reflecting and diffusing surfaces. Consequently, when a bare lamp is used, a distinct degree of discomfort is experienced from glare which results in a diminution of acuity. Local lights, of course, must again be provided over the gauges and indicators.

Smoking Room.

Here, again, decorative effect is the chief thing to be considered, but adequate illumination must be provided, in order that card games may be indulged in without eye strain. Two to three foot-candles should be sufficient.

State Rooms and Berths.

Where the decorations of the rooms demand it, the electric lighting fittings should be so designed as to be in harmony. Such apartments are essentially bedrooms, but at the same time must be the lady's boudoir, the gentleman's dressing room; and they are not uncommonly called upon to take the place of the hospital ward. Despite the minimum space available, passengers expect comfort, and it is here that the lack of comfort is most noticeable. A warm and cosy effect is required but at the same time sufficient illumination is necessary for the dressing table.

To meet all these conditions needs special consideration, particularly as some of these requirements are common to all classes of passengers. An illumination generally of 1—2 foot-candles seems necessary, supplemented by local lights.

Cargo Vessels.

The amount of lighting on cargo vessels is considerably less than that found in passenger steamers, but it would seem that it is equally imperative even on these vessels that the lighting of the working parts, such as the galleys, engine rooms and crews' quarters be sufficiently illuminated, and below are some figures

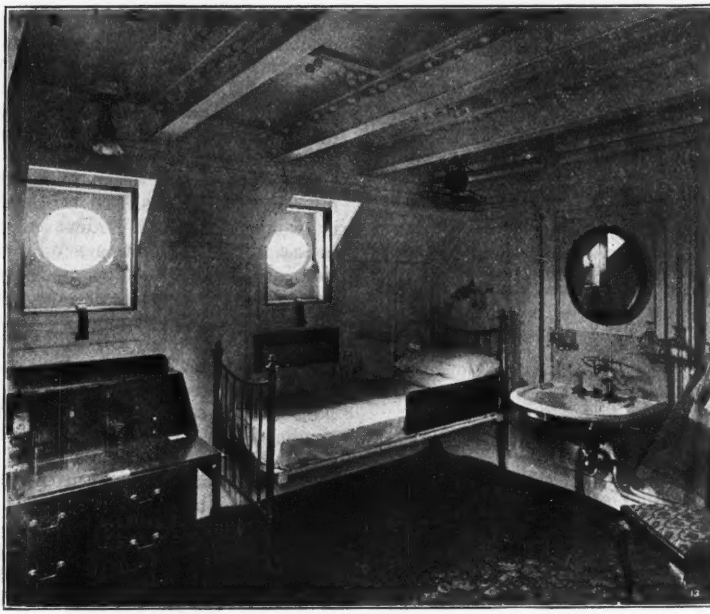


FIG. 7.—Showing method of lighting berths.

FIG. 8.—Showing lighting of covered deck-promenade.

taken from such a boat which also carried a few first class passengers :—

S.S. "Umtali."

Saloon (with 40-watt 100-volt lamps spaced 6 ft. apart)	1·5 f.c.
Companionway (with 30-watt lamps)	0·6 f.c.
Corridor (dark wood, units spaced 12 to 15 ft. apart)	0·8 f.c.
Pantries	1·8 f.c.
Working Galley	0·5 f.c.
Boiler Room	0·5 f.c.
Tunnel (unit placed over bearing) ..	0·5 f.c.
Engine Room—Well glass fittings, with 30-watt metal filament lamps.	

The surroundings of the engine room were dark, and presented a dismal appearance. Local lights were placed, of course, near gauges and indicators.

S.S. "Port Adelaide."

This ship was essentially a cargo vessel with provision for carrying approximately 12 first class passengers. Below are a few readings taken :—

Engine Room	3 f.c.
Pumps	4 f.c.

The engine room was illuminated by 100-watt vacuum type lamps with large conical reflectors, and the result was distinctly good, the reflector contributing in great measure to this result.

Near Generator (this place was poorly lighted)	0·1 f.c.
Tunnel	0·25 f.c.
Refrigerating Room (on thermometers 0·02)	0·3 f.c.

The amount of light falling upon the thermometers was insufficient to read these instruments with ease, and in view of the fact that they give an indication of the temperature of the various cold storage compartments, it would appear that this is a case of poor lighting.

Evaporator Room	0·3 f.c.
Refrigerating Machinery	0·3 f.c

For the purpose of shifting cargo, 1,000-watt gas-filled lamps were used with focus type white vitreous enamel reflectors and was found to be quite satisfactory.

General.

The lighting in cargo vessels is apparently more difficult because of the small amount of space that is available for the crew and for the engines. The machines in the engine room are consequently very cramped, but it would appear that the engine room would be made more cheerful by the adoption of higher wattage units and provided with reflectors.

The lighting of decks offers several interesting problems. To the landsman it would seem self-evident that the provision of a moderate general illumination on the deck-surface is necessary as an elementary precaution in the interests of safety, and also as an assistance to work. On sailing vessels the amount of work to be done on deck is naturally greater and more complex than on a steamer, and one would imagine that the efforts involved in manipulating sails, etc., in a gale at night would be greatly lessened by ample illumination being available. The installation of an engine of relatively small dimensions driving a dynamo might deserve consideration simply for the purpose of providing artificial illumination unaffected by the wind, apart from its possible utility as a subsidiary means of driving the ship against adverse tides, etc.

Unduly powerful deck-lighting might possibly be objected to on the ground of its interfering with a look-out into the darkness; this condition implies care in avoiding exposure of sources to the eye. Lamps should naturally be shaded and the order of illumination on the deck-surface need not exceed that customary for safety in factories and yards on land.

The lowering of boats is always a matter of some difficulty and lighting for such a purpose should be of considerable help. It is understood that in some vessels that lights are suspended between the davits and are therefore available for use both for lowering and loading the boats. A sufficiency of light for taking on and storing of cargo is necessary as it enables the hands to see moving objects and also permits the man in charge of the hoisting machines to have a clear vision of the working area. Such a provision obviously goes far in the prevention of accidents. In practice it is usual to have lighting units suspended over the coal and cargo hatches,

and slung up in other places to facilitate the handling of material. Such units are shown in Figure 9. In this case the unit takes the form of the ordinary cargo cluster with 6 or 8 vacuum lamps. Some vessels employ arc lamps, but more recently the gas-filled lamp in focus type reflectors has been used with success.

When a ship is loading or unloading at the port, supplementary illumination from the supply on land may be provided, and there are important possibilities in this direction. Portable units of the "floodlight" type can be effectively used to aid in the handling of goods by night and also to facilitate ship-construction and repair. In view of the frequently congested state of traffic

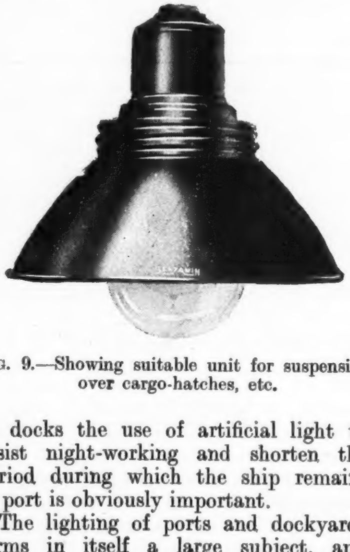


FIG. 9.—Showing suitable unit for suspension over cargo-hatches, etc.

at docks the use of artificial light to assist night-working and shorten the period during which the ship remains in port is obviously important.

The lighting of ports and dockyards forms in itself a large subject, and presents difficulties by reason of the very extensive area that requires illumination. In these circumstances the order of illumination available is necessarily low, and it is all the more important to ensure that this light is distributed as efficiently as possible and to avoid glare from unscreened lamps within the range of vision, such as is liable to cause accidents.

In a handbook of ship calculations, construction and operation by C. H. Hughes, 1917, some interesting data is given concerning the number of lamps that might reasonably be expected in motor boats and yachts. The lighting is usually obtained from secondary cells.

Lamps.

In view of the variety of purposes for which lamps are used on board ship it is not surprising to find a multiplicity of different types in use. At the inception of electric lighting carbon lamps were exclusively used and even now find favour on some cargo vessels.

The introduction of metal filament lamps, however, has effected a considerable saving of electrical energy. The first drawn-wire lamps had their filaments composed of tantalum and these were found capable of withstanding the rough treatment found on board ship. The introduction of tungsten lamps effected a still greater saving in electrical energy; they are gradually replacing carbon lamps, because of their higher efficiency and the whiter quality of the light which is emitted. Although in modern vessels the engines are carefully balanced and the structure designed so as to transmit vibration as little as possible, yet the lamps still experience a considerable amount of vibration of high frequency.

In recent years lamps have been specially designed to withstand great mechanical shock, and such lamps are in daily use on the London trams and on railway systems.

Helical Traction Lamps.

These are made with a spiralised filament and mounted on springy supports. They are so arranged that only short lengths of filament are unsupported. Lamps on board ship are called upon to operate in any position, and the construction of these lamps referred to above prevents the crossing of wires by sagging and vibration. Such lamps bid fair to entirely replace the old carbon lamps.

Of recent years the introduction of gas-filled lamps on board ship has made considerable headway, particularly in the large sizes for the purpose of illuminating the decks and for the facilitation of handling goods, and in quite a number of cases these replace the old cargo clusters with six to seven 60-watt ordinary lamps.

From the reports which have been recently received they appear to be quite satisfactory and are giving good life.

It has already been pointed out that the economic feature of distribution does not call for a high voltage system on board ship because of the comparatively small area which has to be supplied with electricity compared with the amount of energy developed. In view of this fact it is, therefore, not surprising that 110-volt circuits are predominant, although some of the latest vessels which have been constructed have been provided with 220-volt circuits. It will be realised that lamps operating on the higher voltage are not quite so robust in view of the fact that the filament is small in cross sectional area. The strength of a filament varies approximately with the fourth power of the diameter of the filament, and hence the fragility of high voltage lamps, particularly those of small wattage. There is a further point to be noted. In the case of gas-filled lamps the efficiency of the lower voltage lamps is 10 to 15 per cent. greater than those operating at higher voltage, *i.e.*, for the same wattage 10 to 15 per cent. more light is obtained.

From what has been said it will be seen that there is a desirability that a standard voltage should be introduced on board ships, in the Navy and Mercantile Marine. At the present time the various voltages and type of lamps which are asked for, even in different vessels in the same service, increases the expense of manufacturing lamps in bulk, and makes it more difficult to produce lamps of good uniform characteristics.

A further fact to be borne in mind is, that boats are often in port only two or three days, and in those few days it is necessary to obtain further supplies of lamps, and these consequently have to be dispatched at very short notice. It would greatly facilitate matters if lamps, for only one, or at the most two, voltages had to be stocked for marine work in order to deal with these rush orders.

Motor Boat.

Length, 30 ft. to 50 ft.—Twelve 4 c.p. lamps, with 6 c.p. lamps for running and anchor lights.

Yacht.

Length in ft.	Volt.	No. of cells.	No.	C.P.
18—30	6	5	6 12 18	6 6 6
30—45	12—20	10—20	12—18 18—24 24—30	10 10 10
50—75	30	28	26 32 40	10 10 10
90—250	110	100	30—200	16

In conclusion, it would appear advisable that a specific amount of lighting be provided in various parts of ships somewhat similar to that specified by the American Navy, but it must be borne in mind that the specification of lighting alone without common-sense applications of the principles of illumination will not produce satisfactory lighting, and it is possible that in the not distant future the steamship companies will employ illuminating engineering experts in the same way as one or two of the railway

companies have already done. It has been the experience of the railway companies that increased efficiency has resulted from proper and well-planned illumination, and it is, therefore, not inconceivable that similar results would accrue from such a course being taken in connection with ship lighting. In any case whole-hearted co-operation between shipping companies and the manufacturers of electric lighting equipment will help materially to gain this end.

The author would like to take this opportunity of expressing his appreciation of the services rendered by the White Star Line, the Commonwealth and Dominion Line, the Union Castle Line and Messrs. Bullard King of the Natal Line for granting facilities for the taking of readings which have been invaluable in the preparation of this paper.

DISCUSSION.

The CHAIRMAN (Mr. C. H. Wordingham, C.B.E.), in opening the discussion, said they had listened with great interest to a paper on which a great deal of care had been bestowed and on a subject which was rather outside the ken of any except a comparatively small section of electrical engineers. The author had, of necessity, to refer to a few matters connected with the plant and wiring which were not exactly illumination, but he (the Chairman) thought it would be as well for speakers to confine their remarks as far as possible to the question of illumination itself as that was a proper subject for such a society. The subject divided itself into two parts, namely, warship and mercantile marine lighting. Warship lighting, he was afraid, was often dictated a good deal more by such considerations as the slinging of hammocks than the number of foot-candles that were wanted in a particular spot, and also by such considerations as whether it was possible to cram anything more into a compartment than was already there. So that he thought the question that could be discussed with most advantage was the illumination of passenger and cargo vessels.

Mr. F. PURSER FLETCHER (Admiralty) said he felt some diffidence in speaking of this subject, as his experience was largely in regard to the Navy and which the Chairman, as the late Director of Electrical Engineering, was much more capable to discuss.

There must be a greater degree of pleasure in trying to illuminate passenger vessels than one would ever get in lighting warships. When he saw those cosy little berths he thought how nice it must be to have the job of making them artistic by clever illumination. One could also use beautiful fittings, but there were no such nice exhibitions of art in the Navy.

There was probably nothing in common between the lighting of merchant ships and men-of-war. Anyone who had tried to light an oil-tanker or a submarine would appreciate that the difficulties were more than were likely to be met in merchant ships, where the large open spaces in the sitting-rooms and dining-rooms gave one a fine opportunity of satisfactorily illuminating them. On some of those large merchant ships they had 10,000 lights, whereas in the largest ship in the Navy there were not many more than 3,000, and the lighting was not so lavishly carried out. It was simply required to be sufficient to allow instruments to be read and to provide a reasonable degree of comfort in the mess rooms, cabins and compartments of the ship. In battleships the lighting was a difficult matter. The low head-room made it impossible to use reflected lighting with any great degree of success.

He had spent many hours in trying to illuminate the different spaces of ships so as to avoid eye-strain, but with the poorest degree of success. He thought the only case in which he had been pleased with his success was in regard to the lighting of boiler glasses. Some years ago when he was at sea as a mechanical engineer, he had considerable

trouble in satisfying himself in regard to the water level, and he felt sympathy with those who complained that even in ships of to-day it was not satisfactorily arranged for. After a little difficulty he got some fittings arranged similar to an ordinary boiler with its gauge glass and directed a beam of light on to the gauge-glass at different angles, and found that the results one got were widely different. One could have a high candle-power on the boiler fitting, but unless it were directed on to the level at the right angle the results were very unsatisfactory. The results he obtained showed that an illumination given by a 32 candle-power at a distance of four feet and projected on to the boiler glass at an angle of about 10 degrees below the water level gave by far the best illumination or indication of the water level.

In merchant ships the dynamos were near the upper deck, but it was the reverse in the Navy, and there was likely to be trouble with water in the event of the compartment being flooded. The same condition occurred with the wiring. It was difficult to arrange water-tight fittings to be satisfactory in the event of flooding of the compartment. In the American navy figures were given specifying the different degrees of illumination for different spaces. He feared that those degrees of illumination were of very little value. One might ask on what plane these illuminations were to be given. He did not quite see whether it was at the ceiling, or on the deck, or on a plane three feet above the deck. In the barber's shop the height might be very different from what would be required in a prison. These specified foot-candles were useless unless it were specified at what plane the intensity of illumination was to be given. In the merchant service one could use high candle-power gas-filled lamps with considerable satisfaction, but in the Navy it was not at present possible to use them in view of their frailty and inability to withstand the shock effects of gun-fire. Helical traction lamps were also having careful trial and appeared to be the most suitable type for illumination under conditions of gun-fire and shock.

In the Electrical Engineering Department of the Navy attempts were being made to get artificial light similar to daylight. Sheringham shades and various types of daylight glass had been tried in order to get conditions that would not produce eye-strain. With all such systems the nearer one gets to daylight the worse is the efficiency.

In some cases one only got 30 per cent. and in some less.

He felt that this Society was attacking the problem in the right way, and there was a big field before them. The lighting of spaces similar to those necessary on ships was so different from what one met in open roadways and large halls, and if the members of the Society could advise them as to a means of lighting these restricted places it would be much appreciated.

Mr. S. H. Callow said that as a land-lubber he was more interested in hearing the views of the marine engineers than in speaking himself.

One of the principal points, however, that occurred to him after hearing the paper read was that of Economy. In the case of Land Installations when one had settled what was sufficient illumination for the particular purpose, the chief thing aimed at was to obtain such illumination economically and thereby effect as large a saving as possible in the fuel consumed. In the case of Ship Installations, however, not only would the actual fuel consumed to generate the waste electrical energy be saved, but also additional fuel, which would otherwise have been consumed in carrying such waste fuel across the ocean. It would, therefore, appear that the question of Economical Illumination is of particular importance in relation to ship lighting.

Capt. Colin Nicholson said no doubt Mr. Jones could give points to him and other sailormen present in regard to the scientific part of the subject, but they could claim to knowing something about the actual practical working of lights at sea. When he went to sea in 1881, the only light they had was a few colza oil lamps. There were only about three houses to light on sailing ships. The only part of the Paper he would like to refer to was that which referred to proposed lights about the deck of sailing

ships. He thought most practical sailormen would agree that it would be difficult to do any work at all in a sailing ship with even a vestige of light about the deck. Not only was there water coming in on both sides at a time when you were getting knocked about, but there were the ropes to attend to, and if there were electric wires all over the decks, etc., it would take half an hour to explain all the difficulties that would arise. It was outside the range of practicability to have anything in the way of lighting, and he would be sorry to see anything of that kind. He knew he could express the thanks of his colleagues as regarded the other parts of the Paper; and their thanks were due to the Illuminating Engineering Society for giving them the opportunity of attending the Meeting.

Mr. J. W. ELLIOTT said he felt, as one interested in the electric lamps used on board ships, that there was more necessity than ever for standardisation, not only of the lamps, but also of the fittings. The Author forcibly pointed out the need of there being adequate stocks of fittings and lamps, because of the urgency of a vessel reaching port and having to leave in a few days. He thought he would agree that owing to the fact of non-standardisation a great deal of error and disappointment occurred very frequently. For instance, on the diagram the Author showed there were forms of majolica fittings. In those there were quite a number of sizes of openings and different lengths, which necessitated the addition of a longer skirt or flange on the cap so that the attachment could be made.

In regard to the candlepower of the Board of Trade side-lights, he did not know whether it had absolutely been standardised, because one heard that lamps with two 32 candlepower filaments were used and in other cases two 16 candlepower filaments. The spread of filament was standardised, but he believed to-day there were 32 candlepower and 64 candlepower lamps in use for that purpose. These were some of the things the lamp and fittings makers would like completely standardised so that ships could be equipped rightly when they arrived in port.

Lieut.-Com. J. W. A. WALLER (H.M.S. "Vernon") said it was the custom in the Navy to use twice as much candlepower in the starboard light as was used in the port light, on account of the absorption in the green glass compared with the red. With regard to the candlepower per square foot, it seemed to him that the main factor in illumination was the colour and the amount of absorption of light by the surface illuminated. Was there any method of ascertaining the amount of absorption or reflection of light by various coloured surfaces? With those figures one could set about seeing how much light would be required in compartments painted various colours. In boiler rooms there was no reason why the lighting should be bad. In ships that burnt oil there should be little difficulty in keeping the surfaces of the boilers white. It would be best from the illumination point of view, and also there would be less radiation of heat. He supposed they were usually painted black on account of the coal used. It was difficult to see anything, except the lights themselves, where the boilers were painted black.

Capt. E. COLLIER said, that as a seaman of the younger generation, he was greatly interested in the ingenious instrument, described to the meeting by Mr. W. J. Jones, that indicated to the Officer on Watch when any of the navigation lights were out. He thought it was a splendid—a much-needed invention, and that the many navigating officers with whom he came in daily contact would be very interested when he described it to them. As a practical example of when the instrument would prove of exceptional value, he referred to the possibilities of seamen on a vessel's look-out falling asleep, when, of course, they would fail to report the side-lights as out—should they be so. The side-lights were specially mentioned, in view of the fact that the construction of these lights prevents them, as a rule, from being seen inboard by the Officer on Watch.

In conclusion, he referred to the serious consequences a failure to report side-lights as out might have in crowded waters and further intimated that the instrument would undoubtedly be wel-

comed by all ranks of navigators in our Mercantile Marine.

Mr. P. J. WALDRAM said he had looked anxiously for some particulars of the chart-room, which to a landsman appeared to be the most important part of a ship. The only reference to it in the paper was the recommendation by an American that 5-ft. candles should be present in the chart-room. Might he be pardoned—as fools stepped in where angels feared to tread—for trying to focus the attention of such a gathering as that on that point. In a chart-room amply lit it would appear that the reading of the chart would not be so easy as it would in a chart-room somewhat badly lit generally, but with the charts themselves well lit or illuminated from below, which he believed was the custom in the Navy. Might he suggest that possibly if charts could be backed with thin tissue paper appropriately coloured with a lighting-box beneath, it might be possible to secure something closely approximating to daylight conditions—the conditions, by the way, under which charts were prepared. Chart draughtsmen seldom used artificial light, and he believed the charts were almost invariably examined by daylight. For direct daylight illumination by artificial sources, Messrs. Chance's glass absorbed a large amount of light in its present state of development, and with most daylight lamps there was considerable loss of efficiency, but possibly, by strong lighting from below through a thin filter of tissue paper, one might obtain a close approximation to daylight which would enable charts to be read in a chart-room relatively dark with less eye-strain and less loss of efficiency than would be the case with illumination from above through similar glass in fairly well-lighted surroundings.

The suggestion that one could see better at night on a deck which had no lights at all than on one which was lighted was striking, but could readily be appreciated because the eye, which was after all the most important item in illumination, was very apt, when it was struck with a comparatively bright beam followed by intense darkness, to lose its acuity for some seconds—and those seconds might be vital on a crowded deck in a gale. There was another obvious danger in any attempt to render the lighting of a deck at sea equal to the lighting demanded in, say, a goods yard. It would be impossible under the conditions of a rough sea to light it with constant efficiency, and, as they had heard from a high technical source, it was better under those conditions not to light it at all.

If the light failed in a goods yard or factory work could be suspended without much danger, but on a ship failure of the electric lighting system generally synchronised with other emergencies which rendered it vital that men should be able to get to their stations at once. It was obviously highly dangerous to cause them to do so with their sense of feel, direction and touch partially atrophied by having been able to go about their work at night under conditions of ideal safety.

He thanked the author for the opportunity he had given them of appreciating the extreme beauty of design in modern liners. He thought it was not generally known that for some years past the whole of the design of the interior fittings of modern large passenger liners had been entrusted to very eminent architects, and architects were naturally as keen to secure such work as they were competent to execute it. He suggested that every attempt should be made to induce architects to take a greater interest in the science of illumination, which obviously, in this matter of ship work, greatly influenced their work.

Capt. A. I. TAYLOR said that he was greatly interested in the paper. As a master and officer of a vessel, he had often found that lights had gone out, owing to some defect in the engine room. There ought to be regulations providing for some auxiliary means of keeping the lights on. Cargo lights also failed unexpectedly, and it was necessary to rouse the engineer, who might be asleep, in order to get them put right.

Mr. C. L. MATTHEWS said many valuable suggestions had been put forward, especially the one made by one of the naval men present that the green side-light should be more illuminated than

the red, on account of the difficulty in seeing the green light at sea to the same extend as the red. Also he agreed that illumination from below, especially as regarded the compass and so on, was far more practicable than illumination from above. He wished success to the scheme for the improvement of ship lighting.

Mr. C. E. GREENSLADE said one was struck on board ships with the glorious white surfaces there were everywhere and the fact that economy of current appeared to be unnecessary. Whether an extra ton of coal or so was burnt in a day seemed to make practically no difference, in comparison with the large quantity of coal used in driving the ship. It had been suggested that daylight illumination was extremely desirable. As regarded machinery it had always seemed to him that a yellow light, such as that of yellow flame arc lamps, enabled one to see the outlines of machinery with greater clearness and less trouble to the eye than the light of the ordinary half-watt lamp did. In certain instances these had been used—the Jandus lamp in particular—on short-distance ferry-boats for cargo work more or less satisfactorily. He did not know whether this question of the colour of the light had been dealt with scientifically to any great extent, in connection with the lighting of machinery, but if any one could give him information on it, it would be interesting.

Mr. FREETH endorsed the remarks of other speakers in regard to the lighting of sailing ships. He would not care to go aloft with the deck well lit as in addition to the objections raised by the previous speakers, there would be the dazzling effect of the constantly moving shadows of the ropes on the sails.

The author mentioned spiralised filament traction lamps. If one looked at the lamps in the tubes and trams it would be seen that the spiralised filaments were nearly all distorted, whereas a straight filament lamp if properly supported stood the vibration better than the spiralised one. If the length of filament between the supports in the spiralised lamps were stretched out it would be found to be as long as or longer than that in the straight filament lamps, and there was also the danger of the adjacent coils short circuiting each other and reducing the resistance of the filament.

Capt. COLIN NICHOLSON said in regard to lighting the charts on the chart-table, there would, no doubt, be difficulties in the way of getting the light from underneath, but as a rule one kept out of the chartroom as much as possible, because on coming out of the light one could see nothing. In coasting or in bad weather the navigator kept the details in his head or knew them by experience, and the chart work was not then as important and necessary as at other times. A mate, who used rather bad language when he (Capt. Nicholson) bumped against him on coming out of the chart house some years ago, recommended him to shut one eye on going into the chartroom and open that eye and shut the other when coming out. For 15 or 20 years after that he adopted that procedure and could see beautifully when coming out of the light.

Mr. A. M. CURRIE remarked that in view of the number of vessels fitted with oil-fuel the method of lighting the parts of the vessel where the oil was stored was of importance. The Board of Trade had issued various regulations on this matter. The ordinary watertight fitting was not proof against the entry of petrol vapour, and the regulations were similar to those applying in mines, where safety lamps had to be used. It would be interesting to hear the views of some gentlemen with practical experience of the methods of lighting suitable for use on oil-fueled steamers and in the vicinity of petrol tanks.

The CHAIRMAN said the Author had referred to the Rules issued a little more than a year ago by the Institution of Electrical Engineers in connection with what he referred to as ship lighting. Those Rules went much further than lighting, and referred to the whole of the electrical equipment of ships. They were a valuable piece of work, carried out by a fully representative Committee drawn from all bodies who were interested in the subject, and the new rules issued by Lloyd's comprised rules taken from

those ship electrical equipment rules of the I.E.E. The influence of Lloyd's was so great that the Institution Rules as adopted by Lloyd's were now in a fair way of becoming universally recognised all over the world. It was very satisfactory to think that this nation, which had up to now ruled the seas, was setting the pace for electrical matters on board ship. The Committee of the Institution worked in close conjunction with the Engineering Standards Association, and whenever the Committee considered that certain fittings were required they asked the Standards Association to draw up a standard specification for those fittings. There was a complete series of weather-proof fittings provided by those standard specifications, so that all the fixing holes were interchangeable for a given fitting, the well-glasses were interchangeable, and it was possible to carry on with a very small number of patterns, which themselves were interchangeable. Standard pressures had also been set up in those rules, and were likely to be worked to.

The Author and others had referred to the difficulties arising from the use of a large number of different pressures. The Navy had not been a sinner in that respect. For the last 15 years there had only been two standard pressures, 100 and 220 volts. It was unfortunate that it was 100 and not 110. For the merchant service they settled on 110 and 220. That was on account of the three-wire system. On the smaller ships 110 volts was sufficient, but on the larger ones 220 volts had such great advantages that it would be very largely adopted. One large shipbuilding firm had employed the three-wire 220 volts system. He did not think it was necessary to go so high as 440 volts, but the tendency was in the direction of higher pressures.

A question that had a bearing on illumination was the enormous diversity in the load on a ship. There were many motors that were only used when the ship was at sea and others that could only be used in harbour. Therefore there must be good diversity in the load, because many of these motors were of large power and were seldom used. A boat hoist motor, for example, was a large machine, and if the forward capstan were worked electrically, that had also a large motor. Some of these motors were not likely to be in operation when much lighting was required. Having provided the generating capacity for those motors, a large part of the cost of providing for ample lighting, *i.e.*, the part which was involved in standing charges—was already incurred, and therefore one could afford to light liberally. It had not the same effect on the fuel, but, as a speaker pointed out, the amount of fuel used in producing light was negligible in comparison with the fuel required for propelling the ship.

This diversity came in again in connection with the ring-main system, which the Author mentioned. That system had been closely connected with his (the Chairman's) name, as he devised the ring system which was used in the Navy. He introduced it and defended it against all comers, and it was still in use and likely to remain so. That system largely reduced the amount of copper necessary for the main distributing conductors. With the old radiating system the quantity of copper used had to be sufficient for the aggregate capacity of the motors and lights that had to be supplied, and each circuit had to be big enough to supply the motors or group of lights fed through it. The diversity being so great, this radiating system entailed the use of several times the amount of copper necessary if the diversity were taken advantage of. With the ring system one only had to provide conductors large enough to take the load which the generators could supply, and the amount of copper was thus greatly reduced. At the same time every point had a duplicate means of supply, while by the other system there was only one path. There was no more conservative class in this world than shipbuilders in regard to their work. Electric motors and appliances on ships always appeared to be looked upon as frills that did not much matter, and in consequence they were not left to experts to design. Usually a ship was wired to no specification, or at best to a specification provided by a non-electrical naval architect, and the result was that the work was really left in the hands of an electrical contractor. Many of them did excellent

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work, but if expert advice was required for land installations it was also required for ship installations.

Mr. L. GASTER said they had listened with great interest to Mr. Jones's paper and also to the remarks of the Chairman who had special experience of the use of electricity on board ship. It was interesting to hear that the consumption of power for lighting usually formed but a small proportion of the total amount of power generated. Yet it would be noted that some of the values of illumination recorded by Mr. Jones seemed unduly low—less than that specified for the class of work considered in the recommendations for the U.S.A. Navy.

If desired the Society would be prepared to form a Joint Committee to study ship-lighting in detail. It should be possible to arrive at some guiding principles which would be of value alike to shipping companies, masters and officers, and the public.

Mr. Gaster also referred to the question of accidents that occurred during the loading or repairing of ships, due to persons falling. Such accidents had been shown to be closely connected with conditions of lighting, and were most frequent in the winter months when artificial lighting was mainly used. He had been informed that since the Summer Time Act was introduced the number of such accidents had materially diminished. He wished to emphasise particularly the importance of properly arranged and adequate lighting on stairways and in the vicinity of moving machinery.

Mr. W. J. JONES (in reply):—

The discussion has proved very fruitful in view of the fact that it has enabled a number of people with great experience concerning naval and marine matters to speak with authority concerning Ship-Lighting, and the opinion of such people from a practical point of view is of paramount importance.

In general, the discussion shows that the lighting on board ship is not all that is to be desired, and as suggested by Mr. Gaster it should be possible to arrive at some approximate conclusions which would be of value to Shipping Companies and to Suppliers of Ship-Lighting Material.

It is obvious that the author was unable to cover the entire ground of ship-lighting in all its ramifications, and he was glad to note that various speakers had drawn attention to several omissions in the paper.

He agrees with Mr. F. Purser Fletcher that there is difficulty in obtaining fittings suitable for all the different spaces on ships, and the lighting of boiler gauge glasses is one of the most difficult propositions. It is, however, satisfactory to note that this difficulty has been overcome, and the arrangement devised by Mr. Fletcher will undoubtedly be welcomed by engineers.

Some query had arisen concerning the figures given for the American Navy; it is obvious that the only satisfactory place to take readings of illumination is at the working plane, and this unless otherwise specified is taken to be 3 feet above the floor.

Lieut.-Com. J. W. A. Waller mentions the difficulty of the boiler room. This situation is rendered particularly difficult to light satisfactorily because of the lack of reflecting media. With the advent of oil fed boilers it should be possible to have the boilers and the boiler room painted white; indeed, such a procedure would help to detect leakage of oil and prove of value in the prevention of accidents that might occur from the presence of explosive gases.

The reflecting powers of various coloured materials are given in one of the Society's journals.

The remarks of Capt. Colin Nicholson and others, concerning lights being placed upon the decks of sailing ships, are of great interest, and raises the question of the advisability of having deck lights on any vessel.

The author was rather surprised to hear Mr. Freeth's remarks regarding Spiralise Filament Traction Lamps, which are entirely at variance with the opinions of the largest users of traction lamps in this country. It is a well-known fact that traction lamps may be called upon to burn at any angle, particularly on the horizontal, and it is under this condition that the sagging on the straight filament lamp becomes serious. It is obvious that if the filament of the spiralised lamp sags as Mr. Freeth suggests, there would be a tendency for the adjacent coils to separate out, and thus there would be no fear of short circuiting. The author understands that Continental manufacturers have practically eliminated the straight filament lamp for traction purposes in favour of the helical type. The above remarks have been borne out by Mr. F. Purser Fletcher of the Admiralty, who mentioned tests which have been carried out in connection with these lamps under gun fire, and it has been his experience that helical traction lamps appear more suitable under conditions of severe shock and vibration.

The author is particularly grateful to the Chairman for his remarks and for the correction concerning the title of rules referred to in the Paper. Mr. Wordingham had a great deal to do with the framing of these rules, and it is gratifying to note that they are being generally adopted.

In conclusion, the author would direct the attention of those interested in Board of Trade lights and visibility at a distance and under varying conditions to a paper which has recently appeared in the "British Journal of Psychology" (Vol. XI., Part 3, April, 1921), by Ll. Wynn Jones, on the subject of "A Method of Measuring Nyctopsis (Night Vision) with Some Results."

THE DIFFUSION OF LIGHT FROM A SEARCHLIGHT BEAM.

We notice that in a paper recently read by Messrs. E. Karrer and U. M. Smith before the Optical Society of America, which is to be published by the Bureau of Standards, a study is made of the diffused light from a searchlight beam. Such diffused light limits the visibility of targets. It contains a certain amount of polarised light and in very oblique directions the amount of diffused light is greater than any simple theory would indicate.

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EDITORIAL.

The Thirteenth Annual Meeting of the Illuminating Engineering Society.

The termination of the twelfth session of the Illuminating Engineering Society finds its activities completely restored to pre-war fields of work, and the range of topics dealt with at meetings has been as varied as in any past year that we can recall. Progress in Illuminating Engineering, The Use and Abuse of Light in Studios for Kinema Film Production, Kinema Studio Lighting, Light as an Aid to Publicity, Motor-Car Headlights, and the use of Artificial Light as an aid to Games and Sports—here we have a series of subjects all appealing to different sections of the community and all involving, for their complete treatment, co-operation with outside experts. The Society was fortunate in obtaining aid of this description, and also in having as Chairmen, on several occasions, gentlemen who had a special knowledge of the subjects considered. Mr. Worby Beaumont, for example, presided over the discussion on "Motor-Car Headlights," and Mr. C. Wordingham, late Electrical Engineer-in-Chief to the Admiralty, over the discussion on "Ship Lighting." In the discussion of the latter subject it was useful to hear the views of representatives of the Admiralty, the Navy, and the Mercantile Marine Service Association, and it is certainly one on which very little information is at present available, and much remains to be learned.

The Society has added to its list several joint committees to deal with problems arising from these discussions. Amongst these the Committee on Kinema Studio Lighting is of special interest, as forming a useful addition to the inquiries of the Joint Committee on Eyestrain in Kinemas, which reported last year. This, again, is also a case where the joint efforts of lighting experts in conjunction with other specialists (*e.g.*, photographers, managers of Kinema Studios, physiologists and ophthalmologists, etc.) is needed.

Many opportunities have also occurred for the co-operation of the Society with kindred bodies, notably the London Safety First Council and its more recent off-shoot the British Industrial Safety First Association. Industrial lighting in relation to health, safety and efficiency continues to excite general interest. While, in this country, the Departmental (Home Office) Committee on Lighting in Factories and Workshops has resumed the work unavoidably in abeyance during the war, in the United States several additional codes of industrial lighting have been issued. Recommendations on Interior Lighting have been issued by the Illuminating Engineering Society in Germany.

One of the most hopeful signs, to which reference was made in our last issue, is the gradual resumption of international activities in illuminating engineering. Amongst these interest attaches particularly to the proceedings at the Session of the International Illumination Commission to be held in Paris during July 4th–7th, with which we propose to deal in our next number. We are glad to note that the Illuminating Engineering Society in Japan is making good progress, and the fact that in Germany it has been found necessary to form a second body devoted to lighting (the Lichttechnische Gesellschaft, with headquarters at Karlsruhe) is evidence of the growth of interest in illumination in that country.

We hope that one of the next steps will be the resumption of full co-operation with the various Corresponding Members of the Illuminating Engineering Society in various cities. The Society has gained much from such intercourse in the past. Naturally during the war one could not count on assistance from such sources to the same degree, but we hope that in the near future we shall see pre-war conditions restored in this respect and even improved upon

It is gratifying to note that the financial position of the Society has been somewhat improved by the new arrangements made last year in regard to fees for membership. The full extension and development of the Society's work would naturally be facilitated by a considerable further increase in revenue, such as might be derived from a substantially increased membership, or from fuller co-operation on the part of the various industries in the lighting field. It would doubtless also aid the carrying out of various investigations which the Society has in view if its work could be brought before institutions and authorities who have available funds that could be devoted to such researches.

Artificial Light as an Aid to Various Games and Sports.

In this country outdoor games have long played an important part in the national life, notwithstanding the fact that climatic conditions are not very favourable. Apart from variable weather the limited daylight in the winter months makes it difficult for the great majority of people to practise games at any time except Saturday afternoon and Sunday, and this condition cannot be alleviated by any such measure as the Summer Time Act, which has proved so useful in extending hours of play during the summer season.

Hence there has been a movement during recent years towards the use of artificial light to enable games to be played at night. In his introductory paper at the annual meeting of the Illuminating Engineering Society, Mr. J. S. Dow reviewed this interesting problem. A distinction was drawn between purely outdoor games which require a considerable area, such as cricket, football and golf, and other games such as lawn tennis, racquets, badminton, etc., which can be played either out of doors or under cover.

Games of the latter type are now quite frequently played indoors. There are in existence a number of covered artificially lighted lawn tennis courts, and badminton has become quite a popular winter pastime. There are available in most cities drill halls and similar buildings which might well be utilised more fully in this way. The problems involved in lighting a space devoted to a game like tennis, where the ball passes rapidly to and fro, are naturally more complex than those applying to gymnasiums, drill halls, etc., where one has not to follow the flight of a moving object. But experience shows that suitable artificial lighting can be contrived with very fair success, though doubtless by fuller study of the conditions one could arrive at a more perfect system. Artificial light, unlike daylight, is readily controlled; theoretically, therefore, it should ultimately be possible to secure artificial illumination as good as daylight and possibly better.

The requirements of each game present a special problem. In most ball-games, however, elimination of glare and good diffusion of light appear essential factors, and it was urged by several speakers in the discussion that the use of dark-coloured balls and light surroundings (in preference to the white balls and black courts and walls used in some covered tennis courts) would make the lighting problem a much simpler one. Such points require to be settled by the joint efforts of lighting specialists and expert players of games, and we hope that the whole question will be taken up by secretaries of leading clubs and sports organisations.

The provision of artificial lighting for purely outdoor games such as football, cricket and golf is naturally more difficult. But even here the problems do not appear insuperable, and in fact artificial light has already been applied to the lighting of football grounds, baseball arenas, and on a limited scale to golf putting greens. In the case of exhibition games, where gate-money is charged, the expense of lighting may not be prohibitive, and the inducement of being able to use the ground by night as well as by day is a strong one. There are also cases, cricket for instance, where practice play by artificial light might be arranged, thus enabling players to " keep their eye in " during the winter.

In judging these matters one must look to the future. What appears difficult now may prove easy in time to come, when new lighting appliances have developed and fuller experience has been gained. In the field of athletics, as in the industrial world, we may yet learn to " turn night into day."

Optical Signalling in the War.

As is generally known the war led to many interesting applications of optics to signalling, especially those of a "secret" character (*i.e.*, signals which could be read by the initiated but were unrecognisable by stray observers). It may be recalled that some interesting particulars of devices to detect approaching objects by the use of invisible heat rays, and to signal with ultra-violet rays were given in a discussion of the American Physical Society in 1919, and subsequently summarised in this Journal.*

We understand that valuable researches in this field were also conducted by Dr. Louis Bell and Mr. N. Marshall, who utilised only the ultra-violet region lying immediately beyond the visible violet, thus avoiding the use of quartz lenses.

Some other methods of secret signalling are described in a recent communication by Messrs. Von Ernst Beckmann and P. Kipping in Germany.† The devices mentioned are three in number. The first method was based on the alternate insertion of didymium and ordinary yellow glass in the path of the signal ling beam. To the naked eye no apparent change in the beam can be seen, but when it is spectroscopically examined the appearance of a dark line in the spectrum, corresponding with the insertion of the didymium glass, is evident. Thus dot and dash signals can be conveyed by the appearance and disappearance of this dark line. A second method involves the formation of a spectrum from the filament of the signalling lamp, in the plane of which a movable fine wire is mounted. The rays of the spectrum are then reassembled and conveyed by a lens to the receiving station. Movements of the fine wire can be recognised when the signalling lamp is viewed through a grating or other analysing apparatus, but are invisible to the ordinary observer. Yet another method is based on the use of a polarised beam of light in the path of which either of two crystal plates can be introduced. The beam, examined through an analyser, appears red or green according as either crystal plate is used.

We understand that substantially similar devices were proposed in this country. If, without disclosing information of a private character, some fuller particulars of such researches could be made known, it would doubtless be seen that this country was in no wise behind others in the application of science to warfare. We may add that the ordinary flashing signalling lamp, even without the "secret" element, is not such a simple apparatus as is commonly supposed. We may refer those interested to a lecture delivered by Mr. A. C. W. Aldis before the Optical Society last year. The problem of obtaining a beam of maximum intensity within definite angular limits from an apparatus which can be easily carried and operated by one hand presents considerable difficulties that were only solved by very careful design of the reflector and the adoption of a suitable filament.

LEON GASTER.

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* ILLUM. ENG., Oct. 1919, p. 295. † PREUSS. AKAD. WISS., Berlin, 1920.

TRANSACTIONS

OF

The Illuminating Engineering Society

(Founded in London, 1909.)

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

ANNUAL MEETING.

(Proceedings at the Annual Meeting of the Illuminating Engineering Society held at the House of the Royal Society of Arts, 18, John Street, Adelphi, W.C., at 7.45 p.m., on Tuesday, May 31st, 1921.)

THE Annual Meeting of the Illuminating Engineering Society was held at the house of the Royal Society of Arts, London, at 7.45 p.m. on Tuesday, May 31st, the Chair being taken by Dr. JAMES KERR.

The Minutes of the last meeting having been taken as read, the HON. SECRETARY read out again the names of applicants for membership announced at the last meeting,* who were formally declared members of the Society.

The HON. SECRETARY then proceeded to read in abstract the usual Report of the Council for the Session (pp. 144–147), pointing out the wide range of topics that had been dealt with in papers and discussions. Allusion was made to the continued extension of the work of the Society through the appointment of additional Joint Committees, and to various opportunities that had occurred for cooperation with other bodies. It was also gratifying to observe that international co-operation in connection with illumination was now being resumed. The acceptance of the Presidency by Mr. J. Herbert Parsons, C.B.E., F.R.S., was recorded with pleasure by the Council.

The following resolution was then moved by Mr. A. CUNNINGTON, seconded by Mr. G. HERBERT, and carried unanimously:—

"That the Annual Report of the Council for the Session 1920–1921 be adopted, and that a vote of thanks be moved to the Council and Officers of the Society for their services during the past session."

Both speakers expressed satisfaction with the progress the Society had made towards the complete resumption of its pre-war activities, and the hopeful prospects for the future.

Mr. GASTER having briefly acknowledged the vote of thanks, the following resolution was moved by the CHAIRMAN, seconded by Mr. J. ECK, and carried unanimously:—

"That this meeting desires to express a cordial vote of thanks to the Royal Society of Arts for the courteous permission to make use of their rooms during the past session, and records its appreciation of the encouragement and support which the Society has received."

This terminated the formal business before the meeting, and the CHAIRMAN then called upon Mr. J. S. Dow to open the discussion on **"Artificial Light as an Aid to Various Games and Sports."** Mr. Dow, in commencing the paper explained that there was much still to be done in

* ILLUM. ENG., May, 1921, p. 115.

this field. He had merely attempted to summarise some of the problems that had to be met, and he hoped that the decision would be the means of interesting club secretaries and players in the possible applications of artificial light.

An interesting discussion then ensued, in which the CHAIRMAN (Dr. JAMES KERR), Mr. H. M. LEAF, Mr. H. A. CARTER, Mr. A. W. BEUTTELL, Mr. M. ROSE, and Mr. J. ECK took part. A communication from Col. HILL, Secretary of the Badminton Association, bearing on the lighting of badminton courts was also presented, and a further contribution from Mr. S. A. B. LANGLANDS referred to various uses of artificial light in connection with football, bowls, etc. A vote of thanks to the author terminated the proceedings, after which the CHAIRMAN announced that the next meeting of the Society would be held at the opening of the new session in November next.

REPORT OF THE COUNCIL FOR THE SESSION (November 1920—June 1921).

(Presented at the Annual Meeting of the Society held at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C., at 7.45 p.m., on Tuesday, May 31st, 1921.)

During the past session the Society has completely resumed its normal activities, and a number of interesting discussions have taken place, in some cases leading to the formation of additional Joint Committees. Various problems on which the Society is now engaged involve the co-operation of the ophthalmologist and physiologist, and the Council therefore records with pleasure the acceptance by Mr. J. Herbert Parsons, C.B.E., F.R.S., of the Presidency of the Society, in succession to Mr. A. P. Trotter. As the first Chairman of Council, Mr. Parsons was identified with the Society's work in its early stages, and he has since frequently rendered valuable services to the Society when questions involving consideration of the effect of light on vision required treatment.

The Council desire to take this occasion of gratefully recording their appreciation of Mr. Trotter's services, both as President of the Society and in contributing to our knowledge of the measurement and application of artificial light. Although Mr. Trotter's removal to the country has led him to resign the Presidency of the Society, members may rest assured that he will retain his interest in its works, with which he has been associated from the inception of the Society.

We record with regret the death of two members of the Society, Mr. G. O. Light, who acted as Honorary Solicitoı since its commencement, and Dr. W. P. Nuël of Liège, who, as a corresponding member, enabled the Society to obtain information of various hygienic aspects of illumination, notably in connection with miners' nystagmus.

MEETINGS OF THE SOCIETY.

As in former sessions, meetings have aptly illustrated the benefits of the principle adopted by the Society of seeking the co-operation of other bodies in dealing with subjects of common interest. At several meetings gentlemen specially conversant with the subject of discussion were invited to preside.

In accordance with the usual practice, the opening meeting of the Society on December 14th, 1920, was devoted to the presentation of reports, and exhibits of novel lighting devices. The usual Report on Progress during the Vacation was presented by the Hon. Secretary, following which there were reports by the Committee on Progress in Electric Lamps and Lighting Appliances, and the newly formed Committee dealing in a similar manner with gas lighting. Among the exhibits may be mentioned some small gas-filled lamps with opal bulbs, designed with a view to the diminution of glare from unscreened filaments, and some interesting forms

of neon lamps, resembling an ordinary glow lamp in appearance and capable of being inserted on an ordinary lamp-holder on a supply of 220 volts. Major Klein gave a brief summary of progress in the design of the Sheringham Daylight, a feature of which is the production of small lighting units suitable for use as portable table lamps. Mr. A. Cunnington described some new methods of lighting railway time-tables adopted at Waterloo Station, and Mr. Dow showed a novel type of illumination-photometer, permitting readings in foot-candles to be obtained direct by the inspection of a scale of values, without its being necessary to manipulate the instrument to obtain balance.

On January 18th a discussion was devoted to " The Use and Abuse of Light in Studios for Kinema Film Production." This formed a useful supplement to the previous discussions before the Society on the lighting of kinema theatres and portable kinema projectors; the discussion was also opportune in view of the attention recently drawn to possible ill-effects of powerful lights at close quarters on the eyes of kinema actors—a matter that had been referred to the Committee on the Causes and Prevention of Blindness working under the Ministry of Health. A number of kinema film producers, photographic experts and other specialists joined in the discussion, and it was decided to form a Joint Committee to study the subject of the lighting of Kinema Studios more fully.

On February 24th a meeting was devoted to " Light as an Aid to Publicity," two papers on " Show-window and Spectacular Lighting," by Captain E. Stroud, and " Illuminated Signs," by Mr. E. C. Leachman, being read. In both these introductory papers the desirability of avoiding glare from unscreened bright lights, and the need for co-operation between exhibitors in order to avoid displays being prejudicially affected by adjacent powerful unscreened lights was pointed out, and special reference was made to the desirability of systematic and scientific methods of lighting in exhibitions. At this meeting a variety of novel forms of illuminated signs were shown.

Another subject that has continued to receive much attention is the design of motor-car headlights, with a view to reconciling the requirements of the drivers of motor vehicles with the needs of approaching pedestrians or drivers of other vehicles who are apt to be dazzled by the powerful beam. A discussion was opened on this subject at a meeting of the Society in 1920, and on March 18th in the present year the study of the matter was carried a step further by the presentation of a paper on " Motor-car Headlights: Ideal Requirements and Practical Solutions," by Major A. Garrard. The paper reviewed the various attempts made to fulfil the requirements mentioned above, and should prove useful to the Joint Committee of the Society which has now been formed to inquire further into this problem. The thanks of the Society are due to Mr. Worby Beaumont, of the Royal Automobile Club, for presiding over this meeting.

As usual, in the discussion of this paper, the co-operation of kindred associations interested in motor headlights was sought. Another opportunity for such co-operation was afforded by the discussion on " Ship Lighting in relation to Safety, Comfort and Efficiency," opened by Mr. W. J. Jones on April 26th. Mr. Jones reviewed the chief problems met with in the lighting of vessels of various kinds, and in the subsequent discussion the Society received the benefit of the experience of representatives of the Admiralty, the Royal Navy and the Mercantile Marine. The presence in the chair of Mr. C. H. Wordingham, C.B E., late Electrical Engineer-in-Chief to the Admiralty, was much appreciated.

The discussion at the Annual Meeting on "The Use of Artificial Light as an Aid to Various Games and Sports," to be opened by Mr. J. S. Dow, concludes a varied programme of subjects for discussion, all of considerable interest at the present time.

Work of Committees.

The various committees of the Society have been actively at work, and a number of new Joint Committees have been established. It will be recalled that prior to the last session a committee was formed to report on Progress in Electric Lamps and Lighting Appliances, and to keep the Society informed of developments in this

field. A similar committee to deal with Gas Lamps and Lighting Appliances has now been formed, with the co-operation of the Society of British Gas Industries, the present members being Mr. J. Bridger (Chairman), Mr. F. J. Gould, Mr. G. Hands, Mr. W. Mattock, Mr. F. C. Tilley (Secretary). The Committee presented a report at the opening meeting of the present session, and it is hoped that its formation will be useful in establishing the best methods of utilising gas for lighting and in keeping the Society informed of the latest developments.

In view of the growing demand for measurements of illumination in various fields of illuminating engineering, notably in connection with streets, factories, etc., it was felt that the time was ripe for the formation of a Standing Committee on Photometry and Allied Subjects, to deal with various outstanding problems. Such a committee has accordingly been formed, and at present includes Mr. A. Blok, Mr. J. G. Clark, Mr. W. C. Clinton, Mr. J. S. Dow, Mr. K. Edgcumbe, Mr. L. Gaster (Secretary), Mr. Haydn T. Harrison, Mr. W. J. Liberty, Prof. J. T. McGregor Morris (Chairman), Mr. A. Stokes, and Mr. A. P. Trotter.

The Committee is already undertaking researches into the accuracy of photometric measurements of various kinds, and has also accepted an invitation to co-operate with the Advisory Committee on Smoke Abatement attached to the Meteorological Office in regard to the absorption of light owing to suspended impurities in the atmosphere.

The Joint Committee appointed to inquire into the question of Eyestrain in Kinemas has now furnished an interim report to the London County Council, which has since been published, by the permission of the L.C.C., in the official organ of the Society. It is proposed that this Committee should continue to act as a permanent source of information. Following the discussion on "The Use and Abuse of Light in Kinema Studios" in January last, it was felt that the question of Studio Lighting likewise presented a useful field for investigation by a suitable Joint Committee. Such a committee has now been formed with the co-operation of various other bodies interested, and has held a preliminary meeting with a view to discussing its method of procedure and outlining its field of work. The present constitution of the committee is as follows :—

Illuminating Engineering Society : Mr. A. Blok, Mr. J. S. Dow, Mr. L. Gaster (*Secretary*), Mr. F. E. Lamplough, Mr. H. M. Lomas, Professor J. T. MacGregor Morris, Mr. F. Twyman.

Incorporated Association of Kinematograph Manufacturers : Capt. J. W. Barber, C.B.E. (London Film Co.), Major Bell (Famous Lasky British Productions, Ltd.), Lieut.-Col. A. C. Bromhead (Gaumont Co., Ltd. (*Deputy-Chairman*), Capt. C. M. Hepworth (Hepworth Picture Plays, Ltd.).

Council of British Ophthalmologists : Mr. J. Herbert Parsons, C.B.E., F.R.S. (*Chairman*), Mr. A. B. Cridland, Mr. S. Mayou, Mr. W. H. McMullen.

Physiological Society : Professor W. M. Bayliss, F.R.S. (*Deputy Chairman*), Dr. H. Hartidge, Professor C. Spearman.

Royal Photographic Society : Mr. A. C. Banfield (*Deputy-Chairman*), Mr. F. C. Toy.

British Photographic Research Association : Dr. T. Slater Price, Mr. F. C. Toy.

It is hoped that the investigations of the Committee will be of great benefit in clearing up various outstanding problems in connection with the lighting of kinema studios.

It has already been announced that, following the discussion on motor-car headlights last year, it was determined to form a Joint Committee to deal with this subject. The present constitution of this Committee is as follows :—

Illuminating Engineering Society : Mr. J. S. Dow, Major A. Garrard, Mr. L. Gaster (*Secretary*), Capt. E. Stroud.

Royal Automobile Club : Mr. Worby Beaumont (*Chairman*).

Research Association of the British Motor and Allied Manufacturers : Mr. H. S. Rowell.

Institution of Automobile Engineers : Col. D. J. Smith.

British Scientific Instrument Research Association : Mr. David Smith.

Commercial Motor Users' Association : Mr. G. W. Watson.

Electric Lamp Manufacturers' Association of Great Britain, Ltd.: Mr. J. E. Edgecombe.

Council of British Ophthalmologists: Mr. S. Mayou.

Physiological Society: Dr. H. Hartridge.

Co-operation with Other Bodies.

In addition to the instances of co-operation mentioned above, the Society has further developed the facilities for joint action with other bodies on subjects of common interest. The arrangement by which the Presidents of kindred associations become, during their tenure of office, members of Council of the Illuminating Engineering Society now applies to the following bodies, whose co-operation has been of great value :—

The Illuminating Engineering Society in the United States; the Illuminating Engineering Society in Japan; the Institution of Gas Engineers; the Institution of Electrical Engineers; the Council of British Ophthalmologists; the Ophthalmological Society; the Physiological Society; the Electrical Contractors' Association; the Society of British Gas Industries; and the Association of Railway Electrical and Telegraph Engineers.

The London "Safety First" Council and the British "Industrial Safety First" Association have been continuing their valuable work, and the fact of the Society being represented on both bodies has enabled the study of lighting in relation to health, safety and efficiency to be actively pursued. Industrial lighting in particular received special attention at the first conference organised by the British Industrial "Safety First" Association at Olympia on September 22nd, 1920, when a paper on "Lighting as an Aid to Safety" was read by Mr. L. Gaster. The importance of this occasion was marked by the fact that the Home Secretary consented to preside during the morning session, while in the afternoon the chair was taken by Lord Leverhulme —an arrangement which aptly illustrated the cordial support given to the movement both in official quarters and in the industrial field.

The Society was also represented, through the person of its Hon. Secretary and other members, at the Conference of the Royal Photographic Society on May 24th, when the question of the selection and use of illuminants for Studio Lighting and other aspects of the use of light in connection with photography were discussed.

The National Illumination Committee has now resumed regular meetings and has been engaged in the preparation of a list of definitions of the chief terms used in illuminating engineering. It will also be recalled that the Illuminating Engineering Society now forms one of the constituent bodies of the Conjoint Board of Scientific Societies, and has taken an active interest in various questions of general importance to scientific societies which have been receiving attention from the Board.

International Co-operation in Illuminating Engineering.

A gratifying indication of the restoration of more normal conditions is the recommencement of international co-operation in illuminating engineering. It has been arranged that a Session of the International Illumination Commission shall be held in Paris during July 4th–9th in the present year, the Hon. Secretary of this Society being one of the representatives of the Executive Committee of the National Illumination Committee in this country. It is interesting to observe that among the subjects to be discussed are several in which this Society has recently been interested, including the design of automobile headlights, the production of lamps yielding "artificial daylight," and the question of regulations for industrial lighting.

Prior to the war great benefit was derived from participation in international congresses where various aspects of illumination were considered. An opportunity for such co-operation was afforded by the Congress of the Royal Institute of Public Health, held in Paris in May last year immediately after the Annual Meeting, when a paper was read by Mr. L. Gaster on industrial lighting, and various other topics such as the relation between inadequate illumination and miners' nystagmus were discussed. Industrial lighting continues to excite much interest, and it may be recalled that

this question is to receive attention from the Section of Industrial Hygiene of the International Labour Office established by the League of Nations at Geneva. With this section Professor L. Carozzi, a valued corresponding member of the Society, is associated as Secretary.

In this country the Departmental (Home Office) Committee on Lighting in Factories and Workshops has resumed its investigations, and in the United States further additions have been made to the number of States having legislative codes on industrial lighting.

The Illuminating Engineering Society in the United States has carried out much useful work. It may be noted that the Illuminating Engineering Society in Germany has now resumed its normal activities and has recently published a comprehensive review of progress in illuminating engineering (*Lichttechnik*, edited by Dr. L. Bloch). It is also understood that a new society dealing with the technicalities of lighting (Lichttechnische Gesellschaft) has been formed at Karlsruhe, and that an institute for technical illumination has been established at the Karlsruhe Technische Hochschule.

Progress continues to be made by the newly-formed Japanese Illuminating Engineering Society, whose first President, Professor Yamakawa, paid a visit to this country in the autumn of last year. On his return to Japan Professor Yamakawa made known the work of the Society in this country and a full account of its activities has since been published in English in the transactions of the Japanese Illuminating Engineering Society. We understand that the question of publishing abstracts in English of the most important papers read before the Japanese Illuminating Engineering Society is also being considered, and this practice will doubtless aid in promoting interchange of views and co-operation between the Societies in this country and in Japan.

Future Prospects of the Society.

As remarked on the occasion of the last Annual Meeting, the new arrangement whereby two classes of members (members and associates) are recognised has operated satisfactorily, and has led to a material increase in the revenue of the Society, which, however, is not yet sufficient to permit the proper expansion of work of which the Society is capable. A considerable increase in membership is therefore essential to the future prosperity and continued development of the Society.

The Council are now preparing the programme of papers for the next session, and invite suggestions from members who are prepared to read papers.

J. HERBERT PARSONS (President).

L. GASTER (Hon. Secretary).

ILLUMINANTS USED FOR STUDIO-LIGHTING.

At a Conference of the Royal Photographic Society on May 24th, a discussion on the Illuminants for Studio-lighting took place. An introductory paper was read by Mr. J. C. Elvy describing methods used in various kinema studios, and subsequently a paper by Mr. L. Gaster was presented in which attention was drawn to the need for fuller data on the relative luminous and photographic efficiencies of illuminants used for studio-lighting. Reference was made to the recent discussion of the Illuminating Engineering Society on this subject, and it was mentioned that the Joint Committee subsequently appointed by the Society to go further into the matter had nominated one of the two representatives of the Royal Photographic Society as Deputy-Chairman. Among other points raised in the discussion may be mentioned the best methods of screening lights so as to produce a diffused effect more closely resembling natural lighting. It was pointed out that in many respects conditions in a portrait studio differ from those prevailing in the taking of kinema films. In the latter case the person is constantly moving about the lighted stage, and it is necessary that the lighting should be equally effective for any position he assumes.

A paper dealing with some fundamental points in the distribution of light was also read by Mr. J. W. T. Walsh.

THE USE OF ARTIFICIAL LIGHT AS AN AID TO VARIOUS GAMES AND SPORTS.

By J. S. Dow.

(Introduction to a discussion held at the Annual Meeting of the Society at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C., at 8.15 p.m., on Tuesday, May 31st, 1921.)

Introduction.

The use of artificial light in connection with games and sports offers a wide field for discussion, and in this introductory paper only a very general survey is attempted. The full treatment of this subject, as in the case of so many others dealt with by this Society, involves co-operation, primarily between lighting experts and specialists in the games considered. The writer has some knowledge of practically all the games mentioned, but his chief aim is to bring the matter before the notice of club secretaries and players so that the problems may be studied in detail.

In this country games play an important part in the national life. Yet climatic conditions are unfavourable to many forms of sport. In the summer (especially since the introduction of "summer time") there are good opportunities for exercise in the evenings. In winter opportunities for playing games are fewer. Most people practically only play on Saturday afternoons, or possibly on Sunday. The time available for football, hockey, etc., on Saturday afternoons is often severely curtailed by failing light during December and January. Frequent rain renders some games, such as lawn tennis, practically unplayable on grass in the winter months, while even in summer uncertain weather often interferes with play. Accordingly "hard courts," using an artificial level surface relatively unaffected by rain (ash, rubble, wood, etc.), have been developed, in some cases under cover. Other games (racquets, fives, etc.) have been similarly treated. In all cases the full advantages of such methods are only secured if artificial light is provided.

In the case of many games involving a large playing area the provision of adequate artificial lighting naturally presents difficulties, partly technical partly economic. However, facilities for providing artificial light have steadily improved, and the cost has substantially diminished. Looking to the future, and disregarding such abnormal periods as the present, when the coal strike sets a limit to the extension of artificial lighting for recreative purpose, the possibilities of artificial illumination for games and sports well deserves study.

Distinction between Exercises and Sports and Ball Games.

The chief difficulty in opening such a discussion as this is one of selection. There are so many forms of games and sports. We may draw a distinction in the first place between exercises, such as fencing, boxing, swimming, gymnastics, etc., and games which involve following the flight of a ball.

The problems involved in artificial lighting are naturally much more complex when a rapidly moving ball is used. It appears that the lighting of a gymnasium, a roller skating rink, or even an arena devoted to athletic sports (running, jumping, etc.), is a relatively simple problem, the conditions being those applying generally to the production of a fairly even illumination over fairly large areas. The chief requirement, doubtless, is that lamps should be mounted high up well out of the range of view of those taking part in such exercises, so as to avoid glare; in a gymnasium the leaving of a clear space for ropes and apparatus is also of importance. Several illustrations of halls and gymnasia so lighted will be shown. The order of illumination provided on the floor is usually about 2—3 foot-candles, which would involve a consumption of 0·4—0·6 watts per sq. ft. when electricity is used, and probably

0·03—0·05 cub. ft. per hour per sq. ft. with low-pressure gas.

In the case of fencing and boxing contests, the local lighting over the area occupied by competitors might probably be higher than the general lighting. The consideration that any lights liable to fall within the direct range of vision should be avoided is particularly important here, as momentary dazzling of the eyes would naturally prove a drawback to a boxer or fencer. This point has been emphasised in connection with certain public contests where very powerful lights at close quarters were used in order to enable kinema films of the event to be taken (ILLUM. ENG., May, 1919, p. 134).

Games that are essentially Played out of Doors.

Passing on to the next form of games, *i.e.*, those involving watching the flight of a ball, we may again put in a special class games that are played out of doors, and for which a very considerable area is usually needed (cricket, football, hockey, etc.). References have appeared in the Press to football matches that have taken place by artificial light. The consumption of electricity necessary to light the area of a football ground would not appear excessive in the case of a permanent ground where there is ample revenue from gate-money. In view of the occasional interference with play by poor light, and difficulties involved by a crowded programme of matches and the occasional postponement of events, the provision of artificial light deserves consideration. If matches could be played at night doubtless many people would attend who could not do so in the day time. A football being a relatively large object, and its motion slow as compared with the flight of the ball in some other games, the actual technical requirements of the game as regards lighting do not seem very severe. The writer has seen football in progress by artificial lighting when the illumination in parts of the area was certainly under 0·5 foot-candle—a value which would probably hardly suffice for spectators at league matches. There are, however, certain problems to be solved. Lights must be mounted high up round the field so as to leave the actual playing space clear, and care would be needed to obtain adequate uniform illumination over the central part of the ground. Some skill would also have to be exercised to prevent glare from lamps interfering unduly with the comfort of spectators. There is the further question of lamps suffering damage from the occasional impact of the football when kicked into touch. For these reasons lamps should be mounted on very high posts, 30 or 40 feet high if possible. Fortunately recent developments in lamps and reflectors render such heights by no means impracticable. Special overhead concentrated lighting from well-screened lights above the goals would probably be useful.

In the case of hockey the smaller ball used, and its more rapid motion, would make lighting more difficult, and there would probably be more difficulty caused by more or less sharp shadows cast by moving players. On the other hand the danger of breakage of lamps by the impact of the moving ball is less. Again the facts that the ball travels mainly on the ground and is white in colour are advantageous. In lacrosse, where the ball is constantly in the air at a fair height, players would be apt to lose sight of it when it rose above the strongly illuminated zone; this applies, in a less degree, to football. This difficulty could probably be met to a great extent by using balls of a light tint, instead of the dark-coloured balls customarily used for football and lacrosse. While the lamps ranged round the ground should be so screened that there is as little glare as possible in the eyes of players and spectators, it would be advantageous to allow a certain amount of light to be diffused upwards. This would serve to reveal a light-coloured ball at a considerable height; the ordinary conditions in daylight play would be reversed, the ball appearing as a light object against the dark sky. Speaking generally, it would appear that in the case of the games considered above, artificial lighting, while presenting some problems, does not impose insuperable difficulties. The application of artificial light in the case of the two games next to be considered, cricket and golf, no doubt involves the most difficult problems of all, but even

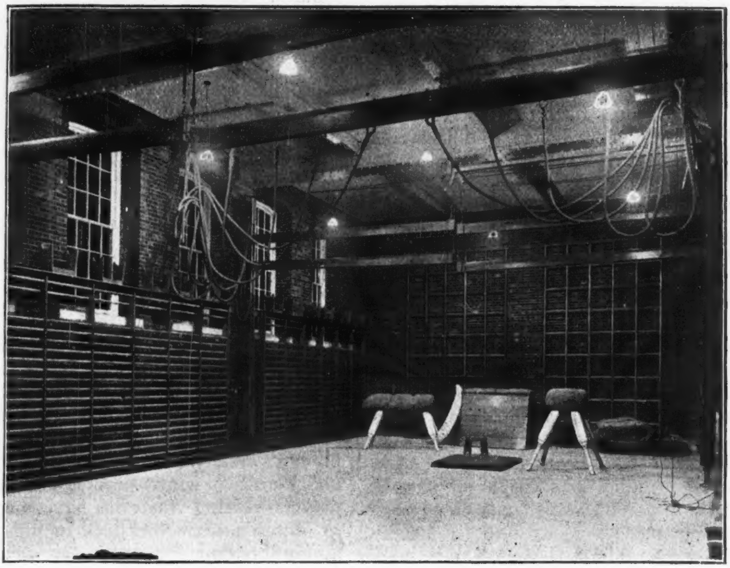

FIG. 1.—Typical example of overhead lighting in a gymnasium, leaving a clear space for manipulation of ropes, etc.

FIG. 2.—Overhead lighting of a drill hall with lamps in opaque reflectors. This answers well for ordinary purposes; but for ball-games it would be desirable to allot more light to the upper part of the room.

these may ultimately be solved by careful study.

The writer has met with little information on the playing of cricket matches by night. Among the problems are the lighting of so large an area, the apparent necessity of some form of powerful local lighting over the wickets, and the fact that the ball travels to such a great height in the air. The speed of a ball delivered by a fast bowler is said to approximate to that of an express train, or even an aeroplâne, and it requires very careful watching. Adequate artificial lighting of the white batting screens placed in line with the pitch could doubtless be easily arranged, but the provision of local illumination over the pitch for the benefit of batsman and bowler would present considerable difficulties. It is of interest, however, to note that in Chicago (ILLUM. ENG. 1910, p. 630) a baseball ground has been artificially lighted, apparently with success. Reliance was placed chiefly on horizontally directed searchlight beams from lights placed round the arena, a ground-illumination of 3 foot-candles being attained. Supplementary overhead lights were also employed. Lights were apparently arranged so that neither players nor spectators suffered unduly from the glare of distant lights. Other games, such as football and lacrosse, were also played in this arena.

In the case of a golf links we have again a very large area to light. There are natural obstacles—trees, etc.—on some links which would be apt to obstruct light. On the other hand players move deliberately and there is less objection to the erection of posts, which might be occasionally struck by the ball, but might be regarded as "natural hazards." The aim would presumably be to provide moderately even illumination by well screened lights over the fairway, and higher local illumination over the putting greens, bunkers, etc. The writer understands that the lighting of a complete golf links has been seriously considered in the United States. Mr. T. J. Little has described the lighting, by incandescent gas, of a small area (40 ft. by 80 ft.) at New Jersey used as a putting green. Four lamps consuming 18–20 cub. ft. of gas per hour each, were used and the illumination on the green was $2\frac{1}{2}$ foot-candles. Holes were painted white inside so as to be easily seen. It was stated that a ball on the green was easily visible 200 ft. away, and sufficient light was allowed to scatter over the ground in the vicinity of the green to permit of mashie-shots from a distance of 100 ft. The cost of the lighting was only seven and a quarter cents (approximately 4d.) per hour.

Thus the use of artificial light to enable golfers to practise putting seems quite feasible. It also seems probable that while it is admittedly difficult to illuminate adequately an entire cricket ground, artificial light might well be used for the local illumination of practice-pitches surrounded by nets. In a fairly large interior it might even be practicable also to lay down cocoanut matting pitches, artificially lighted, for practice under cover in winter. As is well known, players visiting Australia have managed to obtain practice on deck in much less favourable circumstances.

Among other games which are usually regarded as outdoor pastimes may be mentioned bowls. Here the area to be dealt with is relatively small, the actual bowls are relatively large objects, and their motion is slow. Artificial lighting therefore seems by no means impracticable.

A record is available of a bowls match being finished at Highgate by artificial light, and doubtless there have been other cases. In this instance improvised lighting from a series of acetylene flares distributed round the ground was used. As the play can be confined to an avenue of turf permanent overhead lighting by well-screened lights, supplemented by side-lighting, could doubtless be designed in such a way as to avoid misleading shadows being cast by the bowls.

Games suitable for Playing under Cover.

We come next to a series of games that may be regarded as suitable for playing either out of doors or under cover. The most important of these are tennis, lawn tennis, racquets, squash racquets, fives and badminton—to which one might add the humble game of ninepins or skittles.

Tennis, as distinct from lawn tennis, is a game with a long historical record, but necessarily played by relatively few people owing to the special complex court required. One of the best-known examples of such courts is that at the Prince's Tennis and Racquets Club (Kensington). This form of tennis is played under somewhat peculiar conditions in a specially constructed court, the walls and floor of which are composed mainly of smooth grey stone. The latter yield little assistance in diffusing light, and it is therefore desirable that the light-sources should be spread over a big area, giving soft shadows. This court has been lighted by a series of twenty mercury vapour lamps suspended from the girders at appropriate intervals. About 2·2 watts per square foot were expended on the lighting of this court (80 ft. long by 40 ft. broad) and an illumination, 3 ft. above the floor, of 3·5--5 foot-candles was provided. As the ball is often played after bouncing from the walls of the court it is essential that persons standing near the walls should not cast dense shadows. The same consideration applies to fives courts, where mercury vapour lamps have also been used.

Fives courts and squash racquets courts all present comparatively easy problems in artificial lighting as the walls are white and the light is readily diffused. In squash racquets courts particularly, the contrast between the black balls used and the white wall-surface makes it easy to watch the ball. Moreover, we do not meet the difficulties that occur in games like cricket or lawn tennis where the ball may be driven to a considerable height. A good idea of the conditions is afforded by some courts designed by Mr. H. M. Rootham, the artificial lighting of which was afforded by five 50-watt tungsten lamps in Holophane Stiletto reflector-bowls, 14 ft. above the region of the wall used for play. About 0·5 watt per square foot was used, floor-illumination being of the order of one foot-candle. The good diffusion of light by the white walls prevents inconvenient shadows being cast by the players —an important point in all games in which the ball ricochets off the walls of the court. The cost of lighting by this method at eightpence a unit would amount to only about twopence per hour per court.

Lawn tennis is, of course, a much more familiar game than tennis proper, and offers great possibilities for artificial lighting with a view to extending the hours of play. The lighting of lawn tennis courts in the open presents some difficulties as one cannot obtain assistance from surrounding wall-surfaces. Such lighting has, however, been attempted. Data regarding the illumination by incandescent gas of some outdoor courts at New Jersey have been furnished by Mr. T. J. Little. Sixteen lamps, consuming 288 cubic feet of gas per hour, were used per court, the cost working out to about 1s. per court. If several courts, side by side, are lighted the number of lamps

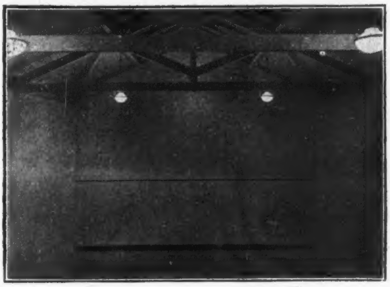

FIG. 3.—Lighting of a Squash Racquets Court by five 50-watt lamps in Holophane Stiletto reflector-bowls.

necessary and expense is naturally reduced. Posts were mounted all round the courts with extending arms ; all such posts, except two on either side of the net, are well removed from the actual area of play. The results are said to have been satisfactory. It is evident that if balls are lobbed high they tend to pass out of the illuminated zone and may be temporarily lost sight of. This difficulty, presumably, must always be met when lighting unconfined outdoor courts, but might be minimised, as suggested in the case of cricket and football, by allowing a certain amount of diffused light to pass upwards.

The well-known covered courts at Dulwich afford an interesting example of what can be done with artificial lighting indoors. Through the courtesy of Mr.

Percy Rootham, the secretary of the Club, the writer obtained full particulars of the lighting conditions shortly before the outbreak of war, and he understands that the method has proved so satisfactory that it has since been retained in substantially the same state. The lighting is effected by 1,500 candle-power high-pressure gas lamps, at a height of 25 ft. Originally these lamps were attached to the girders at intervals immediately above the courts, but afterwards it was found preferable to equip them with special shades and distribute them at the sides so as to be quite out of the range of vision of players. Overhead shielded lights have, however, been retained at the extreme back of the courts so as to enable the figure of the server to be clearly seen. These courts utilise a blackened wood surface and there is a clear height of travel of 35 feet for balls. The walls round the court are also painted a dead black so as to show up the white balls and the white lines of the court in strong relief. Measurements showed that the illumination on the floor of the courts was 4—5 foot-candles and that the contrast between white balls and black court surface was about 10 : 1. The writer was informed that red balls had been tried but were found less satisfactory, the contrast in this case being only 5 : 1. The cost of the lighting at these courts in pre-war days was stated to be approximately 6d. per hour per court.

The design of the above courts was due to Mr. H. M. Rootham who also furnished the writer with particulars of his design, on similar lines, of an electrically lighted covered tennis court in Parliament Street, Liverpool. In this case eight 1,000 candlepower tungsten lamps at a height of 28 feet were spaced round the courts and two special 200 candlepower lamps in conical shades placed over the back lines so as to illuminate the server. The consumption of electricity worked out to 1·5 watts per square foot. (At the present time electric gas-filled lamps would doubtless be substituted.) The cost of the lighting was estimated at about 2s. 6d. per court per hour.

Artificial lighting has also been recently installed for tennis courts at the Queen's Club, of which particulars may be forthcoming. It would be interesting to hear something, in the discussion, of methods adopted in other covered courts. The writer has been informed that the court at the King of Sweden's Palace at Stockholm is lighted by artificial units placed above a diffusing glass skylight, which, during the day, furnishes natural lighting: also that very successful indirect artificial lighting has been adopted for the covered courts at St. Moritz, Switzerland.

The view has been frequently expressed that something of the nature of indirect lighting is the ideal method for tennis courts. The chief difficulty in applying indirect methods is that the space immediately over the courts is necessarily occupied by a glass skylight in order to afford natural lighting by day. Accordingly extensive concealed lighting from above can only be obtained if lights are mounted above the skylight, and the latter filled in with diffusing glass. To the writer it would appear that the difficulties of lighting covered courts have been increased by the fact of white balls and relatively dark-tinted surroundings being adopted. White is the natural colour to use for balls on an outdoor grass court. But would it not be desirable indoors to reverse the procedure, *i.e.*, to have a dead black ball and white surroundings? This method, it may be recalled, is used in squash racquets courts. The use of light surroundings would promote better diffusion of light and might render it possible to use concealed lighting from the side walls. It might be urged that the extensive white area would give rise to a species of glare, but surely this would only be the case if too much light was used. It seems possible that if court and surroundings were white and balls and lines on the court black, a much smaller amount of light might be used and the expense of artificial lighting proportionately reduced.

Badminton, a game that has become increasingly popular of recent years, lends itself readily to indoor play and the lighting does not seem to present any great difficulty. The area occupied is small, and players view the shuttlecock at quite close quarters. Lamps must be well screened and out of the direct range of view of players, but as the flight of motion is low, the lamps need not be

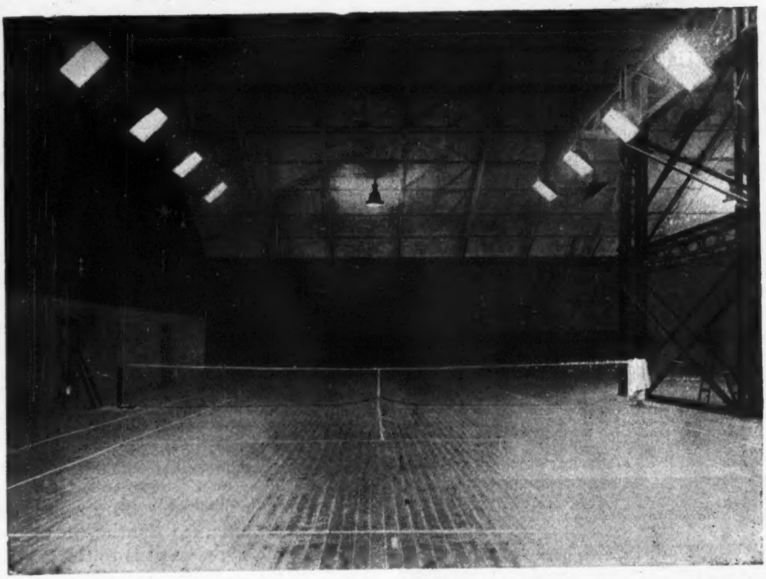

FIG. 4.—View of covered lawn tennis courts at Dulwich lighted by high-pressure gas.

FIG. 5.—View of covered lawn tennis court at Liverpool (Parliament Street) lighted by electric tungsten lamps.

high up. Possibly 10—12 feet would be ample. The skittle-alleys that the author has seen have usually been lighted with little care. Good examples from the United States exhibit the application of overhead lighting from well-screened lamps, so that no filament or mantle is visible when looking along the course of play. A gradual increase in illumination from the bowling end to the ninepins or skittles at the far-end of the alley may with advantage be aimed at. One possible difficulty is the reflection of light from the polished surface along which the balls travel. This can be partly overcome by judicious placing of the lighting units and by screening the under surface of the shades with translucent materials. In some cases lighting of the alley might be effected by lamps mounted in panels at the sides, overhead

FIG. 6.—View of chessboard showing inconvenient shadows caused by oblique lighting.

illumination being reserved for the ninepins at the extreme end, thus avoiding direct reflection of light to a great extent.

Purely Indoor Games.

In what has been said above the writer has confined himself to games that involve active motion of the player and demand a fairly large space. It has been suggested that something should be said on the use of artificial light for purely indoor games. The chief example of such games of interest from a lighting standpoint is billiards. Here the method of lighting the table has become standardised, and experience would seem to justify the use of the deep cardboard shades whereby the actual sources of light are completely hidden from the eyes of players. It has been suggested that small local lights might also be mounted over the cushions so as to illuminate the pockets strongly. This is a refinement on which the views of billiards-players would be welcome. Occasionally the interests of players are overlooked in arranging the lights in the rest of the room, where only subdued lighting is needed. Any bracket-lights employed should be very completely shaded so that they do not distract the eyes of players at a critical moment; better still, they may be mounted quite out of his normal range of vision.

The lighting of rooms in which cards, dominoes, chess, draughts, etc., are played hardly requires detailed analysis. Providing the fundamental requirements of indoor lighting in regard to sufficiency of light (say 2—3 foot-candles) and avoidance of glare are complied with, the ordinary methods of lighting dwelling-rooms will answer. Chess is notoriously a game that demands close concentration, and it has been suggested that local lighting over the table from well-shaded lights, with subdued lighting in the rest of the room, is best suited to the development of the necessary studious attitude of mind. The writer has played chess in rooms lighted in various ways and cannot conscientiously attribute his mistakes to defective methods of illumination. There is no doubt, however, that the exposure of unscreened filaments or mantles is distracting in any games requiring concentrated effort. Another condition that should be avoided is light falling on the chessboard from an unduly oblique angle. This causes dense shadows of the pieces which are apt to be troublesome.

In rooms devoted to card-playing the writer favours moderate diffusion of light. It is, for example, undesirable to attempt to light the card-table by a central shaded light, leaving the rest of the room in comparative darkness. The illumination on the table may be ample, but some players may find it difficult to make out the cards in their hand unless supplementary diffused light is coming over their shoulder. In the effort to see their cards they are apt to incline them horizontally, so as to get more light, thus exposing the contents of their hand.

In this paper an attempt has been made to review some of the problems that arise

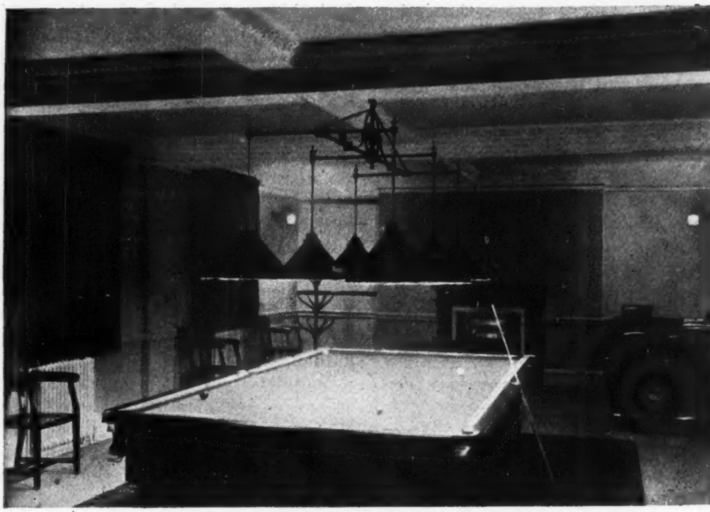

FIG. 7.—Typical billiard table lighting by six 55-watt electric lamps in cardboard shades.

in the playing of games by artificial light, but the writer fully recognises that much remains to be said, and that valuable additional information may be contributed by specialists in the various games considered. It is to be hoped that the discussion will elicit information of this description, and that the paper will be useful in inducing secretaries of clubs to explore the subject further and extend the present possibilities of playing games by artificial light.

DISCUSSION.

Mr. H. M. LEAF said he would be glad to give the meeting the benefit of any experience he had had. He agreed with everything Mr. Dow had said, and in his opinion the paper was of very great value.

He would confine his remarks to the games in which he had had some experience, namely, real tennis, hard-ball racquets and squash racquets.

As regards real tennis (as distinct from lawn tennis) he thought it a mistake that these courts should be invariably dark in colour, using white balls. Hitherto no club had had the courage to try painting the walls white and using dark coloured balls; if only this were done the hours of play by natural light would be prolonged and the courts be enabled to earn more money. If artificial light was employed the problems of lighting would be greatly simplified. In games of this description it is very difficult to overcome prejudices, and the cost of altering the colour of a court is considerable. Real tennis is a very old game, and the colour of the walls of the various courts has always been very dark, and the players are accustomed to the colours and would therefore object to any innovation.

Mr. H. M. Leaf said he had been concerned in the artificial lighting of the real tennis court at Princes Club, Knightsbridge, which was carried out by means of about 20 mercury vapour lamps. The result was fairly satisfactory, but the light was not becoming to ladies looking on, and the general opinion among good players was that no important match should be played by this light.

The court at Manchester was lighted by means of eight large arc lamps with very

wide reflectors, and is said to be satisfactory. In Mr. Leaf's opinion, the lighting in this case was chiefly of value in prolonging the hours of play when daylight was waning.

With squash racquets the conditions were different. The game had no old traditions and the courts were usually white and the balls used were black. The result is that artificial light is entirely satisfactory and just as good as daylight—this was proved by the fact in one professional match in which Mr. Leaf was referee; the strokes in some of the rounds amounted to over 70.

Mr. Leaf said that as far as he knew only one hard-ball racquet court had been lit artificially. The problem in this case was very difficult, as the court is 60 feet by 30 feet and the ball is small ($1\frac{1}{2}$ in. diameter), very hard, and travels very fast. The court in this case is lit by means of a number of metal filament lamps, and the result is said to be satisfactory—certainly the hours of play are increased. Mr. Leaf was of opinion, however, that the artificial lighting of hard-ball racquet courts for important matches in fast courts would never be popular. He suggested that one of the reasons of this might be that artificial lighting from above illuminated one half of the ball only. He mentioned also that hard-ball racquet courts are invariably of a dark colour and that white balls are used.

Generally speaking, Mr. Leaf agreed with Mr. Dow that sufficient care had not been taken in the past as regards the natural light in tennis and hard-ball racquet courts. The best example he had seen of real tennis court lighting by natural light was at Bordeaux, where the light came from the roof only, which by its construction enabled the game to be played by diffused light, which was much appreciated by the players.

Mr. Leaf suggested that if electricity were used for the artificial lighting of courts, alternating current should be avoided as players are liable to lose sight of the ball as it crossed the rafters or other objects in its flight.

Mr. H. A. CARTER congratulated Mr. Dow on his excellent paper. He was glad Mr. Dow reasoned so strongly on the desirability of so designing the architecture of a building as to facilitate the installation of artificial lighting. Those who had to design installations on a commercial basis experienced great trouble from the fact that the architectural features of buildings often rendered the ideal method impracticable.

In covered lawn tennis courts it would be quite possible to arrange a series of domes, higher than the ordinary skylights, at properly calculated intervals. In these domes, large groups of units could be mounted, to give good indirect illumination, the sources being entirely hidden.

Indirect lighting, however, was twice as expensive, from the current consumption point of view, as direct lighting. One or two courts with which he had to deal had been quite expensive enough with direct lighting, and he was afraid the proprietors would not take kindly to indirect illumination unless they were in a very fortunate financial position.

He showed a slide illustrating the lighting of Queen's Club court. The installation consisted of 500-watt gas-filled lamps in angle-type reflectors mounted at a height of 25 to 30 feet. A uniform illumination of 3·5 foot-candles was provided, and in the opinion of the professionals it was perfectly satisfactory. There was, however, a certain amount of shiny reflection from the polished floors, but as the exposure for the photograph was 20 to 25 minutes the reflection was rather exaggerated and appeared worse than it actually was.

Mr. A. W. BEUTTELL thought Mr. Dow was entirely right when he said lighting for ball games was all a question of silhouette. He believed any kind of lighting would be successful if one got the proper silhouette. Lawn tennis was probably the most interesting game from the lighting point of view. Under ordinary daylight conditions one got the top of the ball illuminated, and therefore a white ball against a dark background, when the ball was below the eye-level. On the other hand, when the ball was above the eye-level and showing the bottom of the ball, there was a dark silhouette against a bright sky. Yet one did not experience the slightest inconvenience in changing

over from one condition to the other as the ball rose in the case of an underhand stroke, or lob, from one set of conditions to the other, and neither, he thought, would one find any inconvenience under similar artificial lighting conditions. Probably, in the case of an indoor tennis court, it would be best to go on Mr. Dow's lines and have the whole of the room as uniformly lighted as possible—simply relying on the silhouette. He believed the illumination cast by the walls and ceiling, without any direct light illuminating the top of the ball, would be sufficient when looking down upon the ball below the eye-level, if the floor were black. With regard to badminton courts, the great difficulty was that one spent the greater part of the time looking upwards at the shuttle at a very high angle, and there was sure to be some time at which the line of vision would be exactly coincident with any source of direct light. In the case of badminton he thought satisfactory conditions could be got by having a uniformly lighted room and having the silhouette of a dark shuttle against a light background.

Mr. M. Rose said in reference to Mr. **Carter's** remark, the Queen's Club was lit up with double the usual light when that photograph was taken. He had seen fine players make beautiful shots there, which proved that they could see the ball from one end of the court to the other. He did not say the Queen's Club courts were perfect, but one must have something to work upon. He, himself, had to do with fitting up that court, and he had got certain ideas which he would try to use for the coming session, which, no doubt, would improve it considerably. He could not say anything further until he got permission from the Club to go on with the experiments. As Mr. Dow said, it was all done by experiments. An expert who measured the illumination said that the distribution of light was very even, and he congratulated him (Mr. Rose) on this first attempt at fitting up a lighted covered court.

View of the covered lawn tennis court at Queen's Club, West Kensington, artificially lighted by gas-filled lamps in special reflectors round the sides of the court.

He had had much to do with the lighting of squash racquet courts. He had fitted up the light at Queen's, and the players there never had anything to say against it. They were the most perfect courts that could be found. Iron white enamel shades were used with a lamp in the centre, six in each court, three each side, and they did not give any glare or affect the players.

Mr. JUSTUS ECK agreed with the author that indirect lighting should be adopted for all kinds of covered courts, for with it one came to something that was similar if not superior to daylight illumination. From what had been said his view was that it did not matter whether the ball was lighted from above or below so long as there was general illumination round the players and they did not suffer from glare. That was the important point that could never be achieved by direct lighting, whether from arc or half-watt lamps.

Dealing with the half-watt, or gas-filled lamp he would not like it to go out, as an agreed statement, that indirect lighting required twice as much current as direct lighting; if the speaker, who referred to the cost, had stated 25 per cent. as the increased cost of totally indirect he would have been inclined to agree with him.

For an open-air space—a much more difficult problem than indoors—he still believed there was ample opportunity of using flame arc lamps. Half-watt lamps had a tremendous vogue lately, as during the war the correct carbons were unobtainable and the flame arc lamp had faded out of use, but it was very cheap, and cast its illumination downwards where it was needed. It also lent itself to the cheap and effective illumination of covered places where there was a glass ceiling, and in fact had been the forerunner of the "domes of light" mentioned during the evening. Domes of light, with flame arc lamps, would be most efficient, and he believed feasible even where cost of running had to be carefully considered.

The lighting of Olympia during the Reinhardt performances a few years ago was marvellous, and so far as he could recollect entirely by overhead searchlights placed in transverse galleries in the apex of the roof. Nobody complained of glare, the entire spectacle was most enjoyable and clearly visible.

With regard to rooms for card playing semi- or totally indirect lighting was the solution. Bright light on the table was a fetish that had come into existence without proper justification.

Billiard table lighting also suffered from vogue, for by daylight an overhead luminous ceiling was the approved form of illumination and at night a six or eight-armed arrangement of drop lamps was adopted; obviously the correct thing was to make the ceiling luminous by night and at the same time improve the appearance of the billiard room.

The CHAIRMAN (Dr. James Kerr) said every time he came to that Society there seemed to be some new vista opened up for exploration, and Mr. Dow had certainly entered on an avenue which had been dealt with very little heretofore by other than rule-of-thumb methods and practical experience. Mr. Leaf had given them an excellent review, and the other speakers had also added to Mr. Dow's suggestions. He (the Chairman) could not give the experience of an expert, although he had a good deal to do with observing the effect of these things on the eye and the health.

The subject raised was a very large financial question, because as education progressed everyone became aware of the necessity for town dwellers having sufficient exercise, and exercise was becoming an urgent question in relation to continuation schools, and the adult as well as the adolescent. Games would undoubtedly become more usual in the evenings if they got the conditions required.

Neither dense shadows nor illumination with no shadows, but well lighted walls were wanted; everything up to the horizon of the vanishing point on eye level should be as light as possible. The sources of light must be very large, which meant that they must have diffusing shades to avoid the sharp black shadows of balls and other things that were used. On the other hand, absolutely indirect lighting was inadvisable except for such things as cards. Where they were dealing with questions of parallax and movement, something more than indirect lighting was required. Indirect lighting for games caused a certain absence of perspective and of clear stereoscopic vision. There must also be some direct lighting to give shadows and stereoscopic effect to aid judgment of distances. With absolutely indirect lighting one got little contrast. As was mentioned at a previous meeting of the Society, when the Anatomical

Theatre was started at Cambridge it was on a resplendent scale with entirely indirect lighting, but when they came to dissections the work could not be done for want of contrast, and direct lighting had afterwards to be put in. In games a black ball would be an advantage against a general light illumination.

He agreed with all Mr. Dow's suggestions, and he felt that a good step forward had been made in focusing the opinions of those who had taken part in the discussion and in bringing together the experience of the men who had played the games and experienced the effect of the lighting with the theoretical judgment of the illuminating engineer which Mr. Dow had given them.

Colonel ARTHUR HILL, Hon. Secretary and Treasurer of the Badminton Association (*communicated*):—

I much regret that I am unable to be present at your meeting. I am much interested in the illumination by artificial light of courts for games, especially for badminton. I have given much time and thought to this and very much wish that we could get expert opinion for some universal system, especially as the game has increased in popularity so greatly during the past season. For the coming season we expect a busy time, especially in towns during the long winter evenings. Last year I was so frequently appealed to that I drafted a few hints of which the following is a rough summary. I have had several letters from the secretaries of clubs in this country, and also in Canada, approving of the suggestions and confirming the improvement made by these methods in the lighting of their individual courts.

I see it is mentioned in the paper that dark (black) walls are considered satisfactory for lawn tennis halls. For badminton a shade of green (light) or brown is most satisfactory.

The following are some hints for the artificial lighting of badminton courts:—

Source of Light.—Electric arc or incandescent lamps, gas, incandescent burners and oil lamps may all be used.

Position.—The source of light should always be placed in a line and at each end of the net, about one to two feet clear of the posts.

Brackets to carry Lights.—In the case of incandescent gas lights, these should be placed on inverted T-shaped brackets which must hang suspended from the roof or beams in a line with the net, each arm projecting in a direction parallel to and about one to two feet clear of the side lines but not more than about four feet on each side of the net line.

Height of Lights from Ground.—This must depend largely on the height and size of the hall and also the colouring of the walls; generally speaking from 10 feet to 14 feet will suffice.

Number of Sources of Bracket.—This naturally depends on the power of the sources. A row of eight to ten burners of 50 candlepower should be sufficient for each bracket; if the walls and roof are very dark, more may be necessary.

Shading.—With very powerful lights it may be necessary to shade the sources; opalescent shades are most satisfactory.

Reflectors.—If the walls and roof are very dark some sort of reflector may be advantageous; anything of an unduly brilliant nature should be avoided; a long screen made of boards or canvas painted a dull white would answer the purpose.

Mr. S. A. B. LANGLANDS (*communicated*):—

I wish success to the discussion. One of our leading football clubs (in Glasgow) has for many years placed "Lucigen" lights around their field in the winter and carried on practice games. In Canada games of bowls are carried on under electric arc lighting. Some of the visiting teams have reported on this in pre-war days.

Mr. J. S. Dow (in reply): Most of the discussion has dealt with the lighting of covered courts (tennis, lawn tennis, racquets), etc.—admittedly one of the cases of the use of artificial light for games that has been most studied. It would be interesting to hear something further regarding outdoor games, but doubtless this will develop in course of time.

Most of the speakers agreed on the desirability of diffused light and avoidance of harsh shadows. I am glad that Mr. Leaf, with his considerable experience,

approved the general suggestions in regard to tennis courts. Evidently, as he and Mr. Beuttell agree, light floor and walls and dark balls would simplify the lighting problem, and the objection to this seems to be largely based on custom. As Mr. Leaf points out, conditions in real tennis courts with dark grey walls and floor are very difficult; with such a small ball the question of uneven lighting of its surface, with a relatively dark lower portion, may well give rise to difficulties. One advantage of white surroundings is that one then relies chiefly on "silhouette," and the trouble of uneven lighting of the ball would not arise.

The methods described by Mr. Carter in connection with the Queen's Club court resemble others mentioned in the paper. They are doubtless as good as can be contrived where an existing court, with fixed architectural features, has to be lighted, and where dark walls and ceilings are used; it would seem, however, that the difficulty of polished reflection from the floor is almost bound to occur in such cases. (It has sometimes occurred to me that the Rubber Growers' Association, in their search for new uses of rubber, might apply themselves to the possibility of prepared rubber-linoleum surface for the floors of covered courts. These would presumably not polish and would be less trying to the feet than wood, but the nature of the rebound of the ball would doubtless be different from what it is on a grass court.) Mr. Carter refers to the expense of indirect lighting, but it is possible that with such methods a lower illumination than the 3·5 foot-candles provided at Queen's Club would suffice.

Mr. Leaf raises an important point—the use of alternating current. With arc lamps this would clearly be inadmissible for games requiring quick movement of ball or players; possibly even with incandescent lamps inconvenient effects might here arise.

It was gratifying to have the views of Colonel Hill on the lighting of badminton courts. This is perhaps the most general case of artificial lighting, as this game is becoming so largely played in the winter. No doubt the method of distributed lights recommended by Colonel Hill gives good results; the choice of reflectors, in view of the dark surroundings, is very important. Apparently even if the lights are placed high up the difficulty mentioned by Mr. Beuttell of players being dazzled by bright surfaces when looking upwards would occur. It seems possible that the ideal method would be the suspension of light, translucent linen screens below the lights, which in this case should be provided with highly concentrating reflectors. While involving some loss of light this device would do much to eliminate glare and would favour uniform distribution of light over the court. As a high order of illumination is probably not needed for badminton, the expense should not be prohibitive. This is, however, rather a counsel of perfection that might be considered in important tournaments.

I agree with Mr. Eck that flame arcs might prove useful for lighting large out door areas; high-pressure gas also commends itself in such cases. Future methods of lighting such areas for games may involve the use of diffused light from large white surfaces, possibly illuminated by searchlight beams.

Dr. Kerr referred to one very important aspect of the use of artificial light for games, namely, for the benefit of children in continuation schools. We must all recognise that it is a pity that better facilities do not exist for young people to play games in the evenings after leaving school. Many schools possess large drill halls or assembly rooms that might well be used for such purposes. Some of the halls owned by Territorial battalions are, I believe, frequently so used.

While the paper has dealt mainly with artificial light, it should be added that under cover the provision of adequate daylight is also important. Means of regulation by blinds, in order to avoid glare from direct sunlight at certain periods of the day, and yet to allow maximum access of daylight as dusk approaches, are of great value. Here again the consideration of the part played by reflection of light from light-coloured surroundings, as Mr. Leaf mentioned, is very important with a view to extending the period of play before artificial light becomes necessary. Reference has already been made to the great value of "summer-time" in this connection.

INDEX, June, 1921.

TOPICAL AND INDUSTRIAL SECTION.

[The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona-fide* information relating thereto.]

G.E.C. STUDIO ARC LAMPS.

In a list issued by the General Electric Co., Ltd., special advantages are claimed for the above studio lamps. Ordinary "Witton" carbons in a semi-enclosed lamp with a high voltage long arc. The lamp can be run on either d.c. or a.c. on 200—250 volts. Simplicity of construction and accessibility of parts are good features. Attention is also drawn to the position assigned to the mechanism chamber, whereby inconvenient shadows are avoided, and the position of the lamp on the supporting stand is readily adjustable.

MOTORIST'S SPARE LAMP CASES.

A leaflet has been issued by the General Electric Co., Ltd., giving particulars of a handy case containing spare automobile lamps. These should form a useful item in a motorist's equipment.

On and after Monday, June 13th, the London Showrooms of the G.E.C. will be at the new Head Office at Magnet House, Kingsway. Inspection by visitors is invited.

ANTI-VIBRATION FITTINGS.

We have received from the Engineering and Lighting Equipment Co., Ltd., of St. Albans, some particulars of the firm's fittings for half-watt lamps, and also of the Ross "anti-break" lamp economiser which has previously been referred to in these columns. It will be recalled that this device consists of a small encircling disc composed of phosphor bronze strands so disposed as to damp out shock and vibrations. This device is strongly recommended in cases where breakage of filaments through shock is to be feared. A case in point seems to be furnished by the provision of artificial light to enable games to be played by night. The movements of the players give rise to vibration and there is also the chance of impact from moving balls. A suitable anti-break device should therefore be useful in such cases.

NOVEL USES FOR SEARCHLIGHTS.

We have received from the London Electric Firm some particulars of the various searchlights manufactured by this firm, many varieties of which were supplied for special purposes during the war. In addition to devices for naval and aircraft work, kinema searchlights are supplied, and any kind of mirror, either glass or metal, can be furnished. A typical searchlight is seen in Fig. 1, while Fig. 2 shows a small type mounted on an adjustable tripod stand so that the beam can be turned in any direction. It is suggested that searchlights and floodlights of various kinds might be effectively used for providing artificial light for games, and we understand that the firm hires such apparatus for special displays. Generating plant for searchlight work is also supplied. Either hand or automatic action for searchlights can be obtained, and a change over from one to the other readily effected without flicker.

Areas for games and sports are conveniently lighted by overhead suspended lamps, and the firm has carried out a considerable amount of lighting of this description, for which special raising and lowering gear is supplied.

FIG. 1.—Typical Searchlight.

FIG. 2.—Small Searchlight mounted on adjustable tripod stand.

EDISWAN WAREHOUSE EXTENSIONS.

We are informed by the Edison Swan Electric Co., Ltd., that they have completed considerable extensions in their City warehouse. In future orders and inquiries should be addressed to this department at 123-5, Queen Victoria Street, accounts being still dealt with from Ponder's End. This arrangement takes effect from July 1st onwards.

THE THOR ELECTRIC SAFETY LAMP.

Our attention has been drawn to the miners' lamps manufactured by the Thor Electric Safety Lamp Co., Ltd., of Cardiff. Among other features in the lamp may be mentioned: (1) the use of an ebonite cell, with elimination of inflammable material; (2) the use of a semi-solid electrolyte with a view to avoiding acid-spilling; (3) a special arrangement rendering it practically impossible for lamps to be put on charge with reversed polarity; (4) a patent shock-absorbing arrangement in connection with the bulb, springs being located under the reflector; (5) a simple and effective patent locking joint; (6) the arrangement permitting the cover to be removed without disturbing the plates in any way, so that the latter can be readily inspected.

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The ILLUMINATING ENGINEER

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EDITORIAL.

The International Illumination Commission.

One of the most gratifying recent indications of the restoration of pre-war conditions is the holding of the First Technical Session of the International Illumination Commission, whose activities were inevitably in abeyance during the war. This gathering, which took place in Paris during July 4th–8th, marks the first occasion on which papers summarising progress in various fields of illuminating engineering have been presented, in addition to the ordinary formal business of the Commission. In this respect it has considerably extended the practice of the old International Photometric Commission which, as its name implies, dealt mainly with photometry.

In this issue we present an account of the proceedings (pp. 169–178), together with a summary of most of the papers presented. It will be observed that the unit of light which has been for some years in common use in France, Great Britain and the United States is now formally endorsed as the "international candle," which is fortunately related very simply to the Hefner unit still employed in some other countries. Definitions have

also been formally adopted dealing with luminous flux, illumination and luminous intensity, but the whole question of nomenclature is to be dealt with by one of the series of international technical committees that have now been appointed; other subjects to be treated by such committees include Industrial and School Lighting, Automobile Headlights and Heterochromatic Photometry.

The papers presented, a list of which appears on p. 169, fall broadly into four divisions, namely, those dealing with Definitions and Nomenclature, Physical and Heterochromatic Photometry, Industrial and School Lighting, and Motor-car Headlights. In regard to the two last-named subjects, particulars were furnished of codes and regulations that have been prepared and in some cases adopted, but it was felt that it would be premature as yet to attempt to adopt any detailed codes for international use on a legal basis. This applies particularly to industrial lighting. A summary of progress in this field was presented by the writer, while Mr. L. B. Marks dealt in a very able manner with the codes prepared by the Illuminating Engineering Society. It was generally recognised as most desirable that the chief countries of the world should now require adequate and suitable lighting in general terms, leaving details to be worked out by further research. No doubt the international technical Committee will do most useful work in this direction, paving the way for an ultimate " international code on factory lighting."

In the field of photometry Mr. E. C. Crittenden presented a useful summary of progress in standards of light, a feature of interest being his account of researches on a possible primary standard, based on a black body maintained at a constant temperature. It is also evident from the papers of M. Fabry, Mr. Karrer, Mr. Taylor and others that, considering the complexity of the problems involved in heterochromatic photometry, considerable progress has been made in overcoming the practical difficulties met with in dealing with illuminants yielding light of different colours. We should also like to draw special attention to the valuable paper by Dr. E. P. Hyde, the new President of the Commission, dealing with the mechanical equivalent of light.

It was very pleasant at this gathering to meet so many colleagues in other countries who are working in the field of illumination, and to hear their views on outstanding problems. The Commission had the pleasure of welcoming M. Violle, whose name is associated with valuable pioneering work on incandescent standards, of receiving from Prof. André Blondel a masterly treatise on Photometric Magnitudes and Units, and of hearing the views on factory lighting of M. Gariel, who has been identified with so much work in this field in France. Great Britain was adequately represented at the conference, and we hope that this will also be the case at the next meeting of the Commission, provisionally arranged to take place in the United States in America in 1924. We would like to urge that this country, in view of its past record for pioneering work in many fields, and particularly in industrial lighting, should take a more prominent part in the proceedings, both by the presentation of papers and by action on the various committees. Finally, we sincerely hope that at future conferences the gas industry will be more fully represented. The original International Photometric Commission owed much to the co-operation of the gas industry in various countries. The problems being dealt with to-day by the Commission in general apply to all forms of lighting, and the need is as great as ever that all sections of the lighting industry should take an active interest in its proceedings.

Reconstruction in Belgium.

Amongst the countries represented at the International Illumination Commission, Belgium takes a special place as the home of a number of important international congresses in the past, notably the first International Congress on Industrial Diseases, at which industrial lighting received special attention. Prior to the war the appointment of a State Committee to study this subject was suggested, and we hope that in future Belgium, as a highly industrialised country, will take a prominent part in framing suitable recommendations on illumination in factories and workshops.

Immediately before the meeting of the International Illumination Commission, the writer, as Hon. General Secretary of the British International Association of Journalists, had the privilege of forming one of a party nominated by this body to make a tour of Belgium, and report on its developments. The tour was arranged with the co-operation of the Belgian State Railways and a number of the Belgian municipalities whose hospitality deserves grateful recognition. Opportunities were afforded of visiting all the chief cities, inspecting factories and seeing the scenery of the country, to which must be added the pleasure of meeting our colleagues of the Belgian Press.

Belgium has long been familiar to British tourists, who have now the additional inducement of seeing the spots rendered historic by the Great War. While such areas of desolation as the area round Ypres still exist, one's chief impression was that over the greater part of the country pre-war conditions have been largely restored; many sections suffered relatively little damage, in others traces of the war have been rapidly obliterated. Belgian industrial cities promise to play as important a part as ever in the world's commerce, while such picturesque regions as the Ardennes still retain their old charm.

During their visit the party were graciously received by H.M. King Albert, and were also entertained with great kindness by His Excellency Sir George Graham, the British Ambassador in Brussels. Opportunities were presented of discussing many debateable subjects affecting British relations with Belgium. One could not but recognise how valuable such meetings are in clearing away misunderstandings and developing mutual toleration and respect. Journalists by conversing with their colleagues in other lands learn much that would otherwise pass unrecognised, and as public opinion is so greatly influenced by the Press in either country it is well that they should learn to look at things through others' eyes.

Members of the party carried away most pleasant recollections of the visit. While it is impossible to mention all those who contributed to making the trip instructive and agreeable, one would like to make a special reference to the many kindnesses received from M. Joset, Director of the Publicity Department of the Ministry of Railways, and Mme. Joset, and also to the trouble taken to promote the comfort of the party by M. Defrance, the representative of the Belgian State Railways in this country. Finally, an acknowledgment is due to the courtesy of the South Eastern and Chatham Railway, in granting free return passes to the party from London to Dover.

The Effect on the Eyes of Lights in Kinema Studios.

It will be recalled that, in the course of the discussion before the Illuminating Engineering Society last January* on "The Use and Abuse of Lights in Studios for Kinema Film Production," reference was made to the alleged prejudicial effects on eyesight of actors of certain very powerful lights. This matter had already been referred to a Committee working under the Ministry of Health, which has now issued an interim report (see pp. 179—180).

The Committee has received from Sir Anderson Critchett, hon. ophthalmic surgeon to the Actors' Association, evidence of several cases in which eye-trouble had apparently been caused by exposure to intense lights in studios. It is established that injuries to the eyes of a transient nature have occurred, but no evidence of permanent injuries so caused has been received. Evidence received from experts associated with various kinema studios, from the writer and others, leads the Committee to the conclusion that such injuries are chiefly liable to occur with very powerful unscreened lights It is also concluded that the use of unscreened lights is unnecessary for the purpose of film production, and that better photographic results are obtained when filters are used.

The Incorporated Association of Kinematograph Manufacturers has given an assurance that no member of the Association will in future permit open arc lamps to be used in their studios; and that it will notify to the Ministry any studio among its members unwilling to abide by this condition. In view of this undertaking the Committee think that no further action is necessary for the present, and the conclusion arrived at in regard to the desirability of screening lamps is in accord with views expressed at the meeting of the Illuminating Engineering Society earlier in the year.

The Committee, however, remark that the industry is in a state of development, and that research is required to determine what types of lamps are best adapted to the purposes of film production. It is remarked: "Since new developments may mean new dangers to the artistes, we strongly recommend that this aspect should be made the subject of special investigation, and we are glad to learn from Mr. Leon Gaster that the Illuminating Engineering Society contemplates the formation of a Joint Committee, to include representatives of the kinema industry, lighting experts, ophthalmologists and others interested, for the purpose of studying the whole question."

It is gratifying to have this official endorsement of the value of the work to be undertaken by the Joint Committee, which has now been constituted and has already commenced work. The scope of its researches is naturally much wider than that of the M.O.H. Health Committee, and should prove of great value to the kinema industry as well as the public in clearing up certain outstanding questions and promoting agreement on the best practice to be followed in studios for film production.

LEON GASTER.

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* ILLUM. ENG., Feb., 1921.

THE INTERNATIONAL ILLUMINATION COMMISSION.

Summary of Proceedings at the First Technical Session held in Paris, July 4th–8th, 1921.

THIS gathering, held in the building of the Société du Gaz, was of great interest as being the first technical session of the International Photometric Commission. A considerable number of delegates from Belgium, France, Great Britain, Italy, Spain, Switzerland, and the United States were present at the session, which was opened by the Minister of Public Works, M. Le Trocquer, in the name of the French Republic.

The delegates, nominated by the National Illumination Committee of Great Britain, were: Major K. Edgcumbe (Institution of Electrical Engineers; Chairman of the National Committee), Mr. C. C. Paterson, O.B.E. (Hon. Secretary and Treasurer of the International Commission), Mr. A. P. Trotter (Illuminating Engineering Society), Dr. E. H. Rayner (National Physical Laboratory), Mr. L. Gaster (Illuminating Engineering Society), Mr. R. Watson (Institution of Gas Engineers) and Mr. J. W. T. Walsh (National Physical Laboratory and Assistant Secretary of the International Commission). France was represented by MM. Vautier, Violle, Blondin, Laporte, Janet, Rouland, Brylinski and Fabry; the United States by Dr. E. P. Hyde, Italy by MM. Bohm and Bordoni, Switzerland by M. Filliol, Spain by M. de Artigas, and Belgium by M. Delapole. It was pleasant to observe amongst those present M. Violle, whose name is so closely associated with early researches on the standard of light.

In addition to the formal business of the Commission a variety of interesting papers were presented, with some of which we are dealing in the present issue. The list of papers and communications included the following:—

Photometric Definitions and Units (presented by a sub-committee of the National Illumination Committee in Great Britain); Report of the Committee of the Illuminating Engineering Society (U.S.A.) on Nomenclature and Standards; a Report on Photometric Magnitudes and Units by M. André Blondel; Heterochromatic Photometry by E. C. Crittenden; Problems in Heterochromatic Photometry by Ch. Fabry; Recent Progress in Physical Photometry by E. Karrer; The Function of Relative Visibility and the Mechanical Equivalent of Light by E. P. Hyde; Primary Standards of Light by E. C. Crittenden; the use of Coloured Filters in Heterochromatic Photometry by A. H. Taylor; Reports of the 1919-1920 Committee of the Illuminating Engineering Society (U.S.A.) on Specifications for Automobile Headlights; a Summary of Developments in Industrial Lighting by L. Gaster; the Lighting of Workshops and Factories by C. M. Gariel; a Method of Comparing Illumination subjectively in Factories and Workshops by A. Blondel; Legislation on Lighting in Factories and Schools in the United States by L. Marks. Two communications were also presented by the National Illumination Committee in Italy dealing with Definitions of Photometric Units and Standards and the Properties of the Normal Eye.

The programme also included several social events, which was presided over by the Minister of Public Works. On July 5th a dinner was given to the members of the International Commission by the French National Committee, after which there was a demonstration of Stereo-Photography by M. Lumière. On July 7th a luncheon was given to the French delegates by the delegates of other nations. A striking demonstration of simultaneous presentation of a kinema film and a gramophonic record of speech was given by Mons. A. Gaumont, a feature being a reproduction in this way of an address by Prof. Violle. Some admirable examples of kinema colour-films were also shown. At the close of the proceedings delegates attended a reception at the Town Hall.

Election of Officers and Formal Business.

The officers elected for the forthcoming period were as follows :—

President : Dr. E. P. Hyde.

Hon. President : Mons. Th. Vautier.

Vice-Presidents : Mons. F. Rouland, Sig. G. Semenza and Major K. Edgcumbe.

Hon. Treasurer : Mr. C. C. Paterson.

Hon. Secretary : Mr. C. C. Paterson.

Assistant Secretary : Mr. J. W. T. Walsh.

It was provisionally arranged that the next meeting should take place in the United States of America in 1924.

It was agreed that the amount contributed annually by each country should be apportioned according to its population, viz. :—

For a population of less than 10 million, £25.

For a population greater than 80 million, £200.

For a population between 10 and 80 million, £2 10s. per million.

Discussion also took place regarding the publication of literature relating to illumination. The publication of a special journal by the Commission was deemed impracticable on the ground of expenditure, but it was pointed out that a brief list of papers and articles is already published in the Transactions of the American Illuminating Engineering Society, and it was suggested that this might be extended by the inclusion of abstracts of important papers and that a similar index might be issued in these journals in the various countries dealing with illumination.

The International Commission has also expressed the desire to facilitate the co-operation in its work of certain countries where, in the present exceptional circumstances, it is difficult to obtain full co-operation of all the interests as set forth in the Statutes. It was, therefore, resolved that in such countries a National Committee may be formed for the purpose of affiliation forthwith with the International Commission, provided it be done with the knowledge of all the groups interested in illumination, and provided also that it be understood that this Committee shall accept the collaboration of these groups where they may later desire to be affiliated under the same conditions as the existing members.

The International Commission, however, will only recognise one national committee in each country for the representation of all interests concerning illumination.

Formation of Technical Committees.

In the course of discussions on the various papers presented it became apparent that there were a number of subjects that required detailed study from an international standpoint by means of technical committees.

Thus, while it was generally recognised as desirable that all the leading countries should require adequate industrial lighting in general terms, it was felt to be premature to recommend any series of regulations for general adoption, on a legal basis. Similar considerations apply to lighting in schools, and it was decided to form an international committee to deal conjointly with these two subjects. The Committee was requested to collect information with a view to presenting a report at the next Session, and was constituted as follows :—Mr. L. B. Marks (U.S.A.) (Chairman), Sig. U. Bordoni (Italy), Mr. L. Gaster (Great Britain), with representatives from Belgium, France, Spain and Switzerland to be nominated later.

In regard to automobile headlights, it was also felt that efforts should be made to prepare the way for international agreement on uniform regulations. With this object each National Committee was requested to keep in close touch with the authority in its own country which lays down rules for automobile headlights. It was agreed that a Committee of Study consisting of one member from each country nominated by the National Committee, under the presidency of Dr. C. H. Sharp, should be formed, with the following duties :—

(A) To endeavour to frame technical proposals which shall be suitable for international adoption.

(B) To use the influence of the International Commission to secure in each country recognition of the necessity for international standardisation in this matter, in order to avoid the establishment of a number of different sets of regulations throughout the world.

A third Committee was appointed to study the problem of Heterochromatic Photometry and report to the next meeting of the Commission, consisting of Prof. Ch. Fabry (France) (Chairman), Mr. E. C. Crittenden (U.S.A.) and Dr. E. H. Rayner (Great Britain).

A fourth Committee to consider the question of Photometric Definitions and Symbols and to submit proposals to the next meeting of the Commission was also appointed, and was constituted as follows: Prof. A. Blondel (France) (Chairman), Sig. U. Bordoni (Italy), Dr. C. H. Sharp (U.S.A.), and Mr. J. W. T. Walsh (Great Britain), with representatives of Belgium, Spain, Switzerland to be nominated later. In the case of each Committee the intention was that delegates from the International Illumination Commission of each of the countries represented, in addition to those specified above, should ultimately be appointed.

The International Candle.

One of the most important resolutions adopted by the Commission related to the "international" candle. The unit of candlepower at present in use in this country and in France and the U.S.A. was adopted for international purposes and is to be known as the "international candle." It is maintained by means of electric incandescent lamps at the national laboratories of the three countries named.

Definitions of Photometric Quantities.

A series of definitions of the chief photometric quantities were adopted by the International Commission. In what follows we give the official definitions of these quantities in the official French version, adding at the side our English translation :—

Flux Lumineux.—C'est le débit d'énergie rayonnante évalué d'après la sensation lumineuse qu'il produit. Quoique le flux lumineux doive être regardé strictment comme le débit de rayonnement tel qu'il vient d'être défini, il peut cependent être admis comme une entité pour les besoins de la photométrie pratique, étant donné que, dans ces conditions, le débit peut etre considéré comme constant.

Luminous Flux.—This is the output of radiated energy evaluated according to the luminous sensation which it produces. Although the luminous flux should strictly be regarded as the output of radiation as defined above, it may, nevertheless, be accepted as an entity for use in practical photometry, assuming that, under these conditions, the output may be considered as constant.

L'unité de flux lumineux est le *Lumen.*—Il est égal au flux émis dans l'angle solide unité par une source ponctuelle uniforme de une bougie internationale.

The *Unit of Luminous Flux* is the *Lumen.*—It is equal to the flux emitted within a unit solid angle by a uniform point source of one international candlepower.

Eclairement.—L'éclairement en un point d'une surface est la densité de flux lumineux en ce point, ou le quotient du flux par l'aire de la surface lorsqu'elle est uniformément éclairée.

Illumination.—The illumination at any point on a surface is the density of luminous flux at that point, or the quotient of the luminous flux by the area of the surface, when this is uniformly illuminated.

L'unité pratique d'éclairement est le *Lux.*—C'est l'éclairement d'une surface de un metre carré recevant un flux de un Lumen uniformément reparti, ou

The *Practical Unit of Illumination* is the *Lux.*—This is the illumination of a surface of one square metre receiving a flux of one lumen, uniformly distributed,

l'éclairement produit sur la surface d'une sphère de un mètre de rayon par une source ponctuelle uniform de une bougie internationale placée à son centre.

Par suite de certains usages reconnus, on peut aussi exprimer l'éclairement au moyen des unités suivants.

Si l'on prend pour unité de longeur le centimètre l'unité d'éclairement est le lumen par centimètre carré appelé "*Phot.*" Si l'on prend pour unité de longeur le pied, l'unité d'éclairement est le Lumen par pied carré, appelé "*Foot-candle.*"

1 foot-candle = 10·764 lux = 1·0764 milliphot.

Intensité Lumineuse. — L'intensité lumineuse d'une source ponctuelle dans une direction quelconque est le flux lumineux par unité d'angle solide émis par cette source dans cette direction. (Tout flux émanant d'une source de dimensions négligeables par rapport à la distance à laquelle on l'observe peut être considéré comme provenant d'un point.)

L'unité d'intensité lumineuse est la *Bougie Internationale* telle qu'elle résulte des accords intervenus entre les trois laboratoires nationaux d'étallonage de France, de Grand-Bretagne et des Etats-Unis en 1909. Cette unité a été conservée depuis lors au moyen de lampes à incandescence électriques, dans ces laboratoires qui restent chargés de sa conservation.

or the illumination produced on the surface of a sphere of one metre radius by a uniform point-source of one international candlepower, placed at its centre.

In accordance with certain recognised usages one may also express illumination by means of the following units: If one takes as the unit the length of one centimetre, the unit of illumination is the lumen per square centimetre named "Phot." If one takes as the unit the length of one foot, the unit of illumination is the lumen per square foot, named "foot-candle."

One foot-candle = 10·764 lux = 1·0764 milli-phot.

Luminous Intensity.—The luminous intensity of a point source in any direction is the luminous flux per unit solid angle emitted by this source in this direction. (All flux emanating from a source of negligible dimensions in relation to the distance of observation may be considered as emitted from a point.)

The *Unit of Luminous Intensity* (*candlepower*) is the *International Candle*, such as is derived from the agreement entered into between the three national standardising laboratories in France, Great Britain, and the United States in 1909. This unit has been preserved since this date by means of electric incandescent lamps, in the laboratories which are charged with its preservation.

REPORTS AND PAPERS.

Photometric Units and Definitions.

Reports dealing with the above questions were submitted by a Sub-Committee of the National Illumination Committee of Great Britain, by the Illuminating Engineering Society in the United States, and by Prof. A. Blondel.

The first of these reports deals with several debatable points. The two primary definitions adopted refer to "luminous radiation" and the "luminous source," from which all other definitions are derived. In English flux is used to denote a current or flow rather than a rate, and the word "radiation" conveys the same idea. It appears advisable to use only the word "luminous radiation," and to define the lumen in terms thereof, without introducing the conception of rate. Actually the emission or reception of radiation is analogous to power, and it is proposed to substitute "luminous power" for "luminous intensity," as there is now a tendency to confine the word intensity to a ratio in which the denominator is an area. "Average candlepower" is recommended as a substitute for "mean spherical candlepower." The metre-candle is preferred to the word lux as the unit of illumination; or metre-candle may be used as an alternative

term. In regard to brightness objection is taken to such terms as "equivalent foot-candle," partly as causing confusion with illumination, and partly because the definition assumes a perfectly diffusing surface. The term "efficiency" as applied to watts per candle is obviously unsuitable. Specific consumption is, therefore, preferred to denote the ratio of watts (or British thermal units per hour) to the luminous power expressed in candles.

The following table of symbols for these and other quantities is presented :—

Name of Quantity.	Unit and Abbreviation.	Symbol (in italics).	Defining Equation.
Luminous Radiation	Lumen (lm)	F	—
Luminous Power	Candle (c)	K	$K=\frac{dF}{d\omega}$ Average candle-power $=\frac{F}{4\pi}$
Illumination	Lux	E	$E=\frac{dF}{ds}$
Brightness	Candle per metre² (c/m² or c/mm²)	B	$B=\frac{d(K)}{ds}$ For a perfectly diffusing surface $B=mF\pi$ (projected area)
Reflection } Ratios	Pure Numbers	m	Percentage or Ratio
Absorption } Ratios	Pure Numbers	a	Percentage or Ratio
Transmission } Ratios	Pure Numbers	n	Percentage or Ratio

Conventions suggested: (1) In polar curves the vertical direction should be taken as 0° (downward) and 180° (upward). (2) Angle of incidence and reflection shall be measured from the normal to the surface as zero line.

s is the area of a surface ω a solid angle.

The Report of the Committee of the American Illuminating Engineering Society on Standards and Nomenclature contains the series of definitions framed some years ago and previously published in this journal, to which, however, a number of additions have been made. There are now in all seventy definitions. Besides the primary terms alluded to above various quantities and pieces of apparatus used in photometry (distribution curves, standard lamps, etc.) are defined. The chief quantities are defined in a manner generally resembling that adopted in this country, but some of the symbols are different (for example, I is used to indicate luminous intensity). As some of the symbols are in conflict with those of the International Electrotechnical Commission several special letters (*e.g.*, an inverted L for Luminous Intensity and Greek letters for Luminous Flux and Illumination) are proposed. It will be recalled that this Committee also adopts for brightness the "lambert" (*i.e.*, 1 lumen emitted by a perfectly diffusing surface). A table of visibilities for the average eye with various wavelengths throughout the spectrum is also presented.

Professor André Blondel, in his report, recalls the Electrical Congress in Paris in 1889, when M. Violle proposed his well-known platinum standard, and the subsequent Congress in Geneva in 1896 when he himself presented a series of terms and definitions relating to photometric quantities. This series has since been elaborated, and the list now given is very detailed. Prof. Blondel remarks

that the original proposals have formed the basis of the definitions and symbols subsequently adopted by the American Illuminating Engineering Society. It is pointed out that the lumen is now a familiar term, and Prof. Blondel suggests that it should now be regarded as the fundamental unit. He also prefers the retention of the word "flux," which, in a scientific sense, is properly used, while "radiation" is apt to be employed loosely. "Candlepower," as used in England, is naturally a term unsuitable for other languages, and luminous intensity is considered better in view of its conformation with general physical terminology. Lux, from an international standpoint, is considered better than such compound terms as "metre-candle," "foot-candle," etc. The "phot," as prescribed at the Geneva Congress, renders unnecessary the "lambert" proposed in America. Prof. Blondel also desires to avoid the use of the word "specific" and considers "brilliance" as a suitable French equivalent for the English "Brightness."

Physical and Heterochromatic Photometry.

A number of papers were presented on this subject, among them being a contribution by M. Fabry. Comparisons of lights of different colour may be effected by the methods of (1) equality of brightness, (2) acuteness of vision, (3) flicker photometry, (4) measurement at a certain critical wavelength. Modern practice is confined to (1) and (2). All such comparisons may be more or less vitiated by the Purkinje effect which cannot be completely eliminated, but is of little consequence in industrial work. M. Fabry remarked that the old method of Macé de Lepinay of making measurements in the red and green and deducing the relative integral values of two sources of light therefrom is now obsolete, but Crova's method of using only light as a specific wavelength in the yellow might still have possibilities. Physical methods are in general too complicated or insensitive and devices based on the use of selenium or photo-electric cells have as yet been little used. The insertion of tinted glasses of known absorption in order to equalise colours in the photometric field has advantages, and polarised light in conjunction with a quartz-nicol arrangement to effect coloration might deserve study. In conclusion M. Fabry referred to American researches in this field.

The paper on "Recent Progress in Physical Photometry," presented by Dr. E. Karrer, divides physical photometry into two classes, (1) those in which one forms a spectrum of the illuminant studied then passes this through a filter such that the radiation emerging is proportional to the total luminosity, (2) those in which the light is passed through a special solution, such that the transmission is equivalent with the luminosity curve for the average eye. In either case the rays transmitted are assembled on a thermopile connected to a very sensitive galvanometer. Under favourable conditions comparisons effected by this means agree well with those made by visual methods. The author gives particulars of various solutions devised for this purpose.

Dr. Karrer considers it established that solutions giving a transmission sufficiently close to the curve of visibility of the average eye can be attained. But the selection of the apparatus for measuring the radiation transmitted demands careful thought.

Recent work on selenium shows that such cells do not possess reactions to various parts of the spectrum convenient for physical photometry. The relation between stimulus and response varies with the wave-length, being directly proportional for the longer wavelengths, but following a square-law for short waves. However, the possibility of obtaining high sensibility (isolated crystals are enormously more sensitive than amorphous selenium) is seductive. The Elster and Geitel photo-sensitive cells have attracted attention because of the presumed linear relation between stimulus and response. This relation, however, only exists if cells are specially constructed, and there are other difficulties—for example, the sensibility throughout the spectrum varies enormously with different cells, and even with the same cell as its age advances.

The chief difficulty in all such physical methods is the low sensitiveness, which

renders them only suitable for use in the laboratory. In the case of the photo-electric cell the sensitiveness may be enormously increased by using an evacuated tube. Ultimately, such methods may prove very valuable in certain types of work, for instance, in studying the absorption of coloured glasses.

Mr. E. C. Crittenden's paper gives a brief historical survey of previous work in heterochromatic photometry. It has long been recognised that results obtained with flicker photometers may not agree with those based on equality of vision. Ives formed the conclusion that the latter instrument is preferable as regards consistency when marked differences in colour are dealt with. Results with these types of photometers may agree provided the order of illumination is high, and the portion of the retina used is small (*e.g.*, subtending 2° at the eye). To obtain very accurate results one must correct values so as to apply to the normal eye, involving a large number of observers and laborious work. Experiments on a large number of observers at the Bureau of Standards have shown that even "normal" eyes may differ materially in the weight assigned to the two halves of the spectrum. For accurate work observers should be carefully and systematically selected. Recent work has fortified the view of the merits of the flicker photometer, but various devices have enabled considerable progress to be made with instruments of the equality of brightness type. Among recent devices are the use of graded series of blue-tinted glasses to bring the colour of light from incandescent electric lamps into equality and the "cascade-method," based on the use of a series of lamps of progressively increasing efficiency, studied by Paterson and Dudding at the National Physical Laboratory. In this case results by the cascade-method agreed with those obtained by direct comparison of tints at the extremities of the colour-scale, within 0·3 per cent. Tests made simultaneously over a scale of colours by three laboratories in the United States have agreed within 0·2 per cent. When a comparison is effected between sources which differ very widely in colour the most logical method appears to be to make a spectro-photometric comparison and integrate the results for the normal eye.

The use of filter-glasses to bring into agreement the colour of light from various commercial sources of light and thus render easier their comparison, is discussed in a paper by Mr. A. H. Taylor. Such screens may be tinted blue glass suitable for modifying the light of incandescent lamps, films of coloured gelatine between clear glass, or chemical solutions. Some of the latter are specified in the paper, and tests to standardise glasses (A) by comparison with a Lummer Brodhun photometer using the "cascade" method, (B) by direct measurement with the full difference in coloration, and (C) by means of a flicker photometer show good agreement.

Finally, a valuable paper by Dr. E. P. Hyde summarises researches on the Function of Relative Visibility and the Mechanical Equivalent of Light may be mentioned. An account is given of methods of obtaining this function first by means of a flicker photometer and second by means of an equality of brightness instrument, and the two resultant curves illustrating visibility throughout the spectrum are presented. The curves show good agreement and have the same maximum, but the flicker photometer appears to give a slight preference to the red end of the spectrum, as compared with the direct comparison method. At the end of the paper a table of researches made to ascertain the mechanical equivalent of light is given. Ives and Kingsbury determined the mechanical equivalent of light as 0·00160 watts per lumen. Coblentz found the value of 0·00162. Hyde, Forsythe and Cady give the value 0·00150.

The methods employed in these various researches differed considerably, in some cases the flicker photometer being used, in others the method of equality of brightness, and in the circumstances the agreement appears remarkably good. An earlier result found by Nutting, 0·00120 watts per lumen, is further removed, but it is suggested that this should be regarded as a preliminary observation.

INDUSTRIAL AND SCHOOL LIGHTING.

Five papers were presented in this section summarising developments in different countries.

Mr. L. Gaster, in his contribution entitled "A Brief Summary of Developments in Industrial Lighting," remarked that this subject was discussed in the first issue of THE ILLUMINATING ENGINEER in 1908, January. In 1909 a a useful report was presented to the Conseil d'Hygiène de la Seine by MM. Chantemesse and Walckenaer, and in this year regulations for the lighting of underground bakeries and for certain dangerous trades were announced by the British Home Office. In 1911 the report of the Departmental Committee on Accidents in Factories and Workshops recommended that power to demand adequate industrial lighting should be conferred on the Home Office. In 1912 the determination to appoint a Home Office Departmental Committee on Factories and Workshops in this country was announced. The Committee was formed in January, 1913, and published its first report two years later. Mr. Gaster briefly summarised the contents of this report, which is familiar to our readers. Developments initiated in Belgium and France were delayed by the war, but in the United States, which was less affected by war conditions, considerable progress was made. In 1913 the State of New York commenced the framing of legislation on industrial lighting, and other States followed. At the present time seven States (New York, New Jersey, Pennsylvania, Ohio, Wisconsin, California and Oregon) possess codes of industrial lighting. The principles of these codes are substantially similar, and are also in general accord with those followed in the report of the British Departmental Committee; they are, however, more detailed. Naturally, legislative methods differ in various countries, but it seems desirable that ultimately there may be an "international code" of industrial illumination —a question that has obviously great interest for the Commission.

Mr. L. B. Marks, in a note commenting upon Mr. Gaster's paper, referred to action taken by the American Illuminating Engineering Society in framing a code of industrial lighting prior to the adoption in New York of certain regulations on industrial illumination in 1913. Mr. Marks added that the respective societies in Great Britain and the United States had kept each other informed of developments in their respective countries, and this co-operation had proved of great value.

Further particulars of codes of industrial and school lighting, suitable as a guide to authorities, municipalities, etc., in the United States, were furnished by Mr. Marks in a second paper. The Code of Lighting Factories, Mills and other Workplaces is a *safety* code rather than one for maximum production. This code is now being revised by the American Engineering Standards Committee, but a summary of its contents, pending revision and approval, is given.

In regard to intensity of illumination, seven minimum values are recognised. In roadways and yard thoroughfares 1/50 foot-candle; for storage places, passages, etc., ¼; for halls, stairways, exits and very rough work, ½; where slight discrimination of detail is desired, 1; for moderate discrimination of detail, 2; for finer work 2 and for very minute detail inspection 5 foot-candle.

Section (2) prescribes in general terms the avoidance of glare, objectionable shadows and severe contrasts, no bare light-sources being located within the ordinary field of the workers' vision.

Section (3) prescribes independent lighting for exits and stairways to be unaffected by a failure of the main lighting circuit.

The second part of the paper summarises the Code of Lighting for School

Buildings, which has already been adopted by the State of New York. The following values of illumination are recommended :—

	Illumination in Foot-Candles.	
	Minimum.	Ordinary Practice.
Storage Spaces	0·25	0·5—1·0
Stairways, Corridors ..	0·5	1·0—2·5
Gymnasiums	1·0	2·0—5·0
Rough Shop Work ..	1·25	2·0—4·0
Auditoriums and Assembly Rooms	1·5	2·5—4·0
Class Rooms, Libraries, Blackboards, Laboratories	3·0	3·5—6·0
Fine Shop Work ..	3·5	4·0—8·0
Sewing, Drawing ..	5·0	6·0—12·0

N.B.—Illumination to be measured on important plane (desk-top, blackboard, etc.). Daylight illumination should be at least twice the above values.

Articles are also included prescribing that lamps should be suitably shaded to avoid glare and requiring good distribution of light on the work, and the avoidance of sharp contrasts or objectionable shadows. Walls should preferably be light grey, light buff, dark cream or light olive green, and ceilings and friezes white or light cream. Walls, desk-tops and woodwork should have a matt finish. Switches should be placed at point of entrance to rooms, and emergency lighting, independent of main lighting, should be provided at stairways and exits. Finally, importance is attached to proper inspection and maintenance.

Professor C. M. Gariel, dealing with the lighting of factories and workshops, drew a distinction between general and local lighting. General lighting should be well diffused. Each year accidents occur owing to some part of a workroom being left in comparative obscurity. It is not sufficient merely for no part to be in shadow, the illumination must be sufficient, but the precise values of illumination adequate for various purposes require fuller definition. It is, naturally, desirable to have uniformity of lighting, but provided the variations are not too great, and above all *not too sudden*, moderate differences in illumination are permissible. It is, however, vital to avoid glare, either from the sources of light, or reflections from polished surfaces. At present there is no generally accepted criterion of what constitutes glare. The American I.E.S. Committee on Lighting Legislation prescribes that lamps placed at less than 20 feet above the floor should be furnished with diffusing devices, in such a manner that the source is not directly visible to observers; also that the maximum brightness should not exceed 1·5-3 candles per square inch.

In regard to local lighting similar considerations apply, but here marked variations in illumination, liable to cause eye-fatigue, should be particularly avoided. Also a lamp, even if its brightness is diminished, is fatiguing if continually illuminating the eye at close quarters.

Professor Gariel recalls that in 1881 he presented a report on behalf of a Committee appointed by the Minister of Education mentioning conditions desirable to secure sufficient light. In an article on lighting in the *Encyclopædia d'Hygiène* in 1891, Dr. Rochard recommended a minimum of 5 "bougies decimale-mètre" (approximately 0·5 lux). Miners' nystagmus is attributed to feeble lighting in mines. Professor Gariel refers to the work of Llewellyn and Stassen on this point, and also to various American data confirming the relation between accidents and inadequate illumination.

Reference is next made to the existence of general legislative requirements relating to factory lighting in various countries of Europe up to 1905, the more precise specification of Holland (1895), and the Codes recently adopted by various American States. He remarks that it would be of great value socially for the French Government to be armed with powers requiring adequate industrial lighting in the interests of safety. But in practice it should not be necessary to *enforce* good lighting; it is only necessary to show that improved illumination leads to increased production. In confirmation Professor Gariel quotes figures arrived at in the United States and given by witnesses before the British Home Office Departmental Committee.

The paper presented by Professor A. Blondel suggests the desirability of having some convenient means of estimating the effect of glare in any artificially-

lighted workroom. Broca and Laporte have studied the contraction of the pupil-aperture caused by bright lights. But this method has practical difficulties. Professor Blondel measures the actual subjective brightness of a white card, which is reduced if the eye is exposed to bright lights in the field of vision. In the apparatus employed the observer looks at the illuminated surface through a tube with blackened interior placed before one eye, which is thus shielded from glare due to adjacent lights. The other eye is unshielded. If the eyes are alternately closed and opened, it is found that the surface appears brighter to the screened eye. The degree of greater brightness can be measured by inserting dark glasses in the tube, until the impression of brightness received by both eyes is the same. In one case Professor Blondel found an apparent diminution in subjective brightness due to adjacent lights of about 22 per cent. Such a device appears useful as a supplement to ordinary photometric measurements in factories.

(*To be continued.*)

THE EFFECT OF QUALITY OF GAS ON BURNER EFFICIENCY.

An abstract was recently given in the *Journal für Gasbeleuchtung* of some exhaustive experiments carried out in Germany by Messrs. Terres and Straube on the above subject. Tests were made on both upright and inverted burners with pure coal gas and coal gas mixed with various percentages of water gas, producer gas, etc. In most cases the addition of such gases diminished the lighting efficiency, and carbon dioxide plays an important part in this respect. In the case of the inverted burner, however, the degree of primary aeration is the chief consideration, and alterations in quality of gas are of relatively less consequence. In fact, it appears that as regards change of candlepower produced in this way the inverted burner is at an advantage as compared with the upright type. In the various gases examined alterations in flame temperature were of small consequence, and the efficiency attained depends chiefly on flame-volume.

GAS COMPANIES AND THE SMALL CONSUMER.

In his address before the Scottish Junior Gas Association Mr. J. W. M'Lusky recently referred to the difficulty of defective and small service pipes, met with in some cities, which are conducive to inadequate illumination. In Scotland, for example, the tenement system of living is very prevalent, and one finds vertical service pipes originally designed for a lighting supply to six or more houses now expected to carry a supply for lighting, heating and cooking. The tenants naturally complain of "bad gas." They are then told that unless the property is more adequately piped a good supply of gas is impossible, but they often find it difficult to induce the proprietor to put things right.

In addition there are often small internal pipes and cheap and inefficient lighting appliances to be contended with. These conditions afford a strong argument for a proper system of maintenance, and free advice regarding choice of fittings —a policy that has been adopted by progressive companies for many years. It is added, however, that one of the chief reasons for delay in starting such systems has been the strong opposition of the master plumbers, who resist any attempt on the part of municipal gas undertakings to touch incandescent business. It should not, however, be beyond the combined wit of the gas industry and the master plumbers to formulate a scheme whereby no one would lose business or money, and the consumer would receive better service.

Attention may also be drawn to Mr. M'Lusky's humorously expressed advice to the distribution staff: "Be as good-natured as possible to consumers. Remember how we aggravate them at times. Do not shout at them on the telephone. They will be far more impressed if you are polite and sympathetic. When you meet them in their own homes, and you hear their wonderful descriptions of the stuff they are expected to consume, let your trained intelligence restrain your language, so that the lady next door, who frequently overhears, will be puzzled to know the difference between the minister, the doctor, and the gas department's representative!"

THE EFFECT ON VISION OF LIGHTS USED IN KINEMA STUDIOS.*

It will be recalled that in September last year a Committee was appointed by the Minister of Health "to investigate and report on the causes of blindness, including defective vision, sufficient to impair economic efficiency, and to suggest measures which might be taken for the prevention of blindness." The Right Hon. G. H. Roberts, M.P., was appointed Chairman of the Committee, which comprised Messrs. J. C. Bridge, F.R.C.S., A. Eichholz, C.B.E., M.D., N. Bishop Harman, M.B., F.R.C.S., J. B. Lawford, M.D., F.R.C.S., E. D. Macgregor, G. F. Mowatt, J. S. Nicholson, J. H. Parsons, C.B.E., F.R.S., F.R.C.S., Mrs. Wilton Phipps, and Messrs. W. M. Stone, J. Taylor, C.B.E., M.D., F.R.C.P., and Stephen Walsh, M.P.

Messrs. R. A. Farrar and P. N. R. Butcher were nominated as Joint Secretaries, and in the present year Mr. C. J. Bond, C.M.G., F.R.C.S., was appointed as an additional member.

During the last three months of 1920 complaints were made of injury to the eyes of actors and actresses working in kinematograph studios, caused by intense lights used for the production of films. A question on this subject was asked in the House of Commons, and the Minister of Health referred the matter to the Committee for consideration and report.

The Committee, besides taking evidence, visited a large studio and witnessed the actual production of films.

Sir Anderson Critchett, Bart., honorary ophthalmic surgeon to the Actors' Association, gave evidence as to five patients, one actor and four actresses, who had recently consulted him on account of eye trouble following exposure to the intense lights used in studios. Mr. Alfred Lugg, Secretary to the Actors Association, also stated that transient attacks of pain and inflammation of the eyes have of late occurred frequently among actors and actresses engaged in film production. Other witnesses stated that the attacks of inflammation occur within a few hours after leaving the studio, the sufferer awakening from sleep the same night with pain and smarting in the eye. These symptoms yield to simple remedies, and last, at most, a few days.

The Committee regards it as established that, as a result of their occupation, injuries to the eyes of a transient, and in most cases trivial, nature, have recently occurred among kinematograph artistes. They have had no evidence of serious or permanent injuries so caused. In this country, practically all complaints received date from the last three months of 1920, and coincide with the introduction and injudicious use of certain very powerful arc lamps of the searchlight type, largely imported from America.

As to the types of lamp used in kinema studios, the Committee received evidence from Mr. Leon Gaster, Honorary Secretary of the Illuminating Engineering Society; Mr. Ruthven Murray, M.I.C.E., who has made a special study of the supply of energy to and lighting of kinema studios; Mr. Maurice Elvey, chief producer, and Mr. Paul Burger, chief photographer of Stoll Picture Productions, Limited; a deputation from the Incorporated Association of Kinematograph Manufacturers, Limited; Mr. L. V. Cargill, F.R.C.S., who has made a report to Stoll Picture Productions, Limited, on the alleged danger from the lamps used; and Mr. Lamplough, director of research for Messrs. Chance Brothers, Limited.

The evidence of these witnesses is to the effect that—

(1) Injuries to the eyes have occurred in kinema studios from the use of

* Abstract of an interim report presented by the M.O.H. Committee on The Causes and Prevention of Blindness.

unscreened* arc lights. (2) No injuries have occurred from the use of adequately screened arc or mercurial vapour lamps. (3) The use of unscreened arc lights in these studios is not necessary.

On this evidence we offer the following observations:—

Before the use of these exceptionally powerful unscreened arc lights for film production, cases of injuries were rare. About May, 1920, new patterns of arc lamps of the searchlight type were imported from America, and have since been used in several British studios. In some instances during the latter months of 1920 the diffusing glass screens ordinarily provided with such lamps were not used; injuries have occurred in these circumstances.

Unscreened arc lamps are liable to cause injury by reason of the unimpeded access of ultra-violet rays to the eyes. The danger is increased according to the proximity of the eyes to the lights and to the duration of the exposure. Goggles have been provided as a form of protection, but do not appear to be generally worn, and their use during the actual production of films appears impracticable.

In certain types of arc lamp used in kinema studios, the cores of the carbons emit irritating vapours composed of suspended particles and products of combustion. Danger might arise from this source, but it is unlikely to be serious unless the lamps are very close to the artistes. It is possible that danger might arise from the artistes looking directly at the lights, even if these were properly screened, owing to the intensity of the luminous rays. Permanent damage to sight has been caused, for example, by viewing eclipses of the sun with the naked or inadequately protected eyes. There is no evidence that any such injury has been caused in kinema studios, and the Committee is of opinion that suitably enclosed and screened arc lights are not likely to be dangerous apart from culpable temerity on the part of the artistes.

The evidence of electric light experts and photographers is to the effect that not only is the use of unscreened arc lights unnecessary for the purpose of film production, but that better photographic results can be obtained when filters are used. The screens ordinarily used are of spun glass, which diminishes the glare, and cuts off the greater part of the dangerous ultra-violet rays.

The Incorporated Association of Kinematograph Manufacturers, Ltd., an association which comprises practically all the film-producing firms in this country, is so much impressed by the evidence of danger to the eyes from unscreened arc lights, that it has given its assurance to the Minister of Health that—

> ". . . in no case will any member of the Incorporated Association of Kinematograph Manufacturers, Ltd., from now onwards, and as has been the case for some weeks past, permit any open-arc lights to be used in their studios for general illumination without glass filters, and the Association is willing to be responsible for its members in that respect, undertaking to notify to the Ministry any studio among its members unwilling to abide by this condition."

The Committee is of opinion that their undertaking should be accepted, and that further action is unnecessary for the present. However, the industry is in a state of development, and research is required to determine types of lamp best adapted to film production. It is added:—

"Since new developments may mean new dangers to the artistes, we strongly recommend that this aspect should be made the subject of special investigation, and we are glad to learn from Mr. Leon Gaster that the Illuminating Engineering Society contemplate the formation of a Joint Committee, to include representatives of the kinema industry, lighting experts, ophthalmologists and others interested, for the purpose of studying the whole question."

* The term "screen" is used to indicate the glass which encloses or covers the lamp and which cuts off the dangerous part of the ultra-violet-radiation.

TOPICAL AND INDUSTRIAL SECTION.

[The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona-fide* information relating thereto.]

GENERAL ELECTRIC CO., LTD.

Press Visit to Magnet House, Kingsway.

ON the occasion of the Annual General Meeting of the General Electric Co., Ltd., on July 21st, an opportunity was afforded to the Press to inspect the new premises at Magnet House, Kingsway.

In the address of the Chairman, Mr. Hugo Hirst, reference was made to the services rendered to the country during the war by various of the Company's factories, notably the Carbon Works, which maintained a supply of searchlight carbons, and the Lemington Glass Works, where many special bulbs for war service were produced. It was also pointed out that as a manufacturing concern the Company played a great part in providing occupation, and that the amount received by shareholders was relatively small in comparison with that paid out, directly and indirectly, in the form of wages.

As regards the new building, it was evident that every effort has been made to employ labour-saving devices. The lift equipment alone forms an interesting item, and we may comment, in passing, on the illuminated device at the foot showing the exact position of each lift at any moment. Inter-departmental correspondence is distributed by pneumatic tubes, there is a special central service for dealing with the incoming mail, and special arrangements are made for ventilation. The private telephone exchange has 50 incoming lines and 300 internal extensions.

FIG. 1.—General Electric Co.'s Alabaster Ware Showroom.

The showrooms in the basement are on an extensive scale, a feature being the equipment of a series of rooms in different styles, architectural styles, where chandeliers, lanterns, etc., of all kinds may be seen. Amongst exhibits of special interest we may mention the new Harrison street-lighting lantern, which, by a combination of overhead dish-reflector and inclined mirrors aims at producing the necessary accentuation of light at angles slightly below the horizontal. Another novel exhibit in this

FIG. 2.—General Electric Co.'s Silk Shade Showroom.

room was the series of letter-signs utilising neon lamps. These lamps, each of which forms a distinct luminous letter, utilise luminescent neon gas, can be fitted into an ordinary lamp-socket on 200 v. and consume 5 watts apiece. One of the electrodes consists of a stamped out metal letter, the surface of which is covered by an orange-luminous glow, strikingly visible from a distance, but not over-brilliant.

We also noticed, in an adjacent room, some pleasing mantelpiece fittings, consisting of alabaster translucent vases, in which lamps are completely concealed.

The greater part of the ground floor is taken up by the sales counters with a continuous length of 140 feet. There is ample storage room behind the counters and bins are readily replaced from the stockrooms on the upper floors by a series of goods-lifts. The most interesting feature of the sales counter, however, is the endless belt-conveyor under the counters by means of which all purchases are carried to packing benches at one end. Near the counter is shown a handy form of projector using a gas-filled lamp. By this means any device on a lantern slide can be projected on a screen, and if necessary extinguished at regular intervals by an automatic contact-maker.

Besides offices, canteen, etc., the upper part of the building contains a large lecture hall capable of seating 350 people.

BUSINESS IN MANCHESTER.

THE B.T.H. CO. OPEN NEW PREMISES.

IN these days of general depression it is satisfactory to note that quite a number of electric firms are spending money on extensions. The latest instance is afforded by The British Thomson-Houston Company, who have recently secured additional premises at National Buildings, St. Mary's Parsonage, Manchester, to take care of their increasing business in that district in connection with the sale of Mazda lamps, fittings and accessories, and to provide greater storage accommodation.

A part of the extension has been tastefully decorated and furnished as a fittings showroom. Here are exhibited a varied assortment of up-to-date lighting appliances, including, amongst others, "Eye-Rest" indirect fittings, semi-indirect fittings, Mazdalux industrial reflectors, X-Ray window lighting reflectors, street lighting and other lanterns, and floodlight projectors.

It is expected that this new showroom will form an important addition to Manchester's electrical facilities, of which engineers and contractors will doubtless take full advantage. Members of the industry in Manchester and neighbourhood are cordially invited by The B.T.H. Company to visit the showroom, and, should occasion arise, to avail themselves of the advisory services of the engineering staff in respect of any electric lighting or power problems with which they are confronted.

INDEX, September, 1921.

"INSTALLATION NEWS."

The July issue of *Installation News*, published by Simplex Conduits, Ltd., contains some notes of general interest, notably a special contribution on "Earthing of Factory and Works Installations." Some practical hints are given for securing a reliable earth, methods of obtaining which in practice are apt to be somewhat casual. A description is given of the Simplex new pattern handlamp which is designed to comply with the Home Office regulations and is insulated with special care. Other features include watertight fittings for collieries and the Stellite lantern for industrial and street lighting with gas-filled lamps.

We have also received from Messrs. Simplex Conduits, Ltd., a leaflet describing the new "terra-grip" continuity system, which is claimed to provide a cheaper means of effecting good electrical conductivity in light gauge unscrewed conduit installations. The principle of the device is the use of special screws, which, when driven home, expand at the point of contact scraping off any enamel and ensuring good electrical contact.

ACETYLENE CYLINDERS FOR WELDING AND CUTTING.

Messrs. Allen-Liversedge, Ltd., are instituting, from August 8th onwards, a weekly motor delivery service to ensure a quicker and more regular supply of dissolved acetylene. The new arrangement will also facilitate the return of empties. Regular days of delivery have been appointed in the various London districts.

TILLEY "SOFT RAY" HIGH PRESSURE GAS LAMPS.

WE notice that the Tilley High Pressure Gas Syndicate, Ltd., are now equipping their lamps with a small silica envelope, replacing the ordinary large glass globe. This step is stated to have several advantages. Globes of this kind are of a very refractory nature, and are less little liable to crack, and the life of the mantle is lengthened because a slightly damaged mantle need not be at once renewed. As the name applied to these lamps suggests, the light is softened and diffused by the use of the silica envelope in place of clear glass.

EBONITE APPLIANCES.

A catalogue issued by Messrs. Siemens Brothers & Co., Ltd. (Woolwich) contains a summary of various ebonite appliances, including rod, tube and sheet and special mouldings now supplied by the firm. Photographs illustrating the appearance of the works and various processes of manufacture are also included. Reference is made to a new insulating material known as "keramot."

THE BRITISH COMMERCIAL GAS ASSOCIATION.

A Report presented at the General Committee of the British Commercial Gas Association on July 11th indicates that a vigorous campaign of publicity has been maintained, notably in connection with smoke-abatement. The Coal Smoke Abatement Society is organising an exhibition, to be held in London next spring, and the B.C.G.A. is co-operating with the society in this matter. Conferences have been arranged at various cities during the past year with good results, and the association has also been devoting attention to the use of gas for domestic purposes in connection with the various housing schemes. It is interesting to note that experiments are being conducted with a view to converting bakers' ovens to gas-firing. We observe that the association now receives the support of 313 different undertakings, with an annual output of 150,000 million cub. ft. of gas, forming just over 61 per cent. of the industry.

ACETYLENE LIGHTING FOR POLLING STATIONS.

We are informed that a new opportunity for the emergency use of acetylene lighting occurred in the recent Abbey Election. Sites for Polling Stations in and around the City are becoming scarce, and it was found necessary to secure accommodation in part of an old warehouse in Poland Street, Soho. Unfortunately neither gas nor electricity was available, but the difficulty was overcome in an inexpensive manner by the provision of dissolved acetylene flares, the source of light being compressed acetylene in steel cylinders.

THE "KINGSWAY II." MINERS' ELECTRIC HAND LAMP.

The above lamp is described in Leaflet No. L. 2492 issued by the General Electric Co., Ltd. Among other features attention is drawn to the china lampholder and switch plate in one piece, which is stated to be unbreakable and non-corroding. The lamp, rated at 1 candlepower, has a special "bow" filament to ensure uniform brilliancy as well as good mechanical strength. The case is of jointless lead, and the accumulator is of the unspillable variety and is easily removable. The terminals consist of brass caps heavily coated with lead to prevent corrosion. A magnetic lock is also provided.

The various component parts are clearly indicated and numbered so as to be readily replaced from stock. The list also contains particulars of "Kingsway" racks for charging such lamps.

REVIEWS OF BOOKS.

Dynamo and Motor Attendants and Their Machines. By Frank Broadbent, M.I.E.E. (S. Rentell and Co., Ltd., London, 1921. *pp.* 213, 107 *figs.* 4*s.* 6*d. net.)*

The tenth edition of this textbook has been fully revised and brought up to date, among the chief alterations being those in connection with the permissible temperature limits of dynamos and motors and the method of reversing induction motors. The first chapter is devoted to "starting up," after which the author proceeds to explain the principles of electro-magnetism, rules for determining direction of induced currents, etc. We have next a description of alternating and direct current machines, hints on the selection of dynamos, and instructions as to erection. The chapter on faults and breakdowns contains much practical information. Final sections are devoted to starting switches, accumulators, etc. The book is fully illustrated, and we do not doubt but that the tenth edition will be as welcome as its predecessors.

Industrial India. (Monthly Review. The Tata Publicity Corporation Ltd., London.)

We have received a copy of the August issue of *Industrial India*, a monthly journal review devoted to the development of India's resources and industries. India is rapidly developing from an agricultural country into a vast industrial empire. It is stated that there are now only four countries with a larger textile trade. Important iron and steel works have been started. The country has vast mineral wealth, and is fortunately placed in being able to exploit abundant supplies of water-power for the generation of electricity. The journal before us is attractively got up and well illustrated, with a coloured cover, and we wish it every success.

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The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by LEON GASTER

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EDITORIAL.

Progress in Industrial Lighting.

It will be recalled that the Home Office Departmental Committee on Lighting in Factories and Workshops issued interim report in 1915, which ranks among the most important official documents available on this subject. During the latter period of the war the work of the Committee was in abeyance, but its labours were resumed in 1920, and a Second Report has now been issued (see pp. 192-194).

In the original report industrial lighting was dealt with generally, and a recommendation that there should be statutory provision requiring adequate and suitable lighting in factories was made. Values of illumination desirable in the interests of safety and general convenience (apart from that necessary for the efficient carrying out of industrial processes) were also specified. The report now issued deals more fully with the question of what constitutes suitable lighting, in regard to glare, shadow and constancy. The avoidance of inconvenient shadow and objectionable flicker are prescribed in a general manner. The limitation of glare admittedly presents more difficulty, and the recommendation made, prescribing for

bright sources a limiting angle with the horizontal of 20 degrees, and 30 degrees for sources at close quarters, doubtless represents a reasonable compromise, bearing in mind the widely different conditions existing in various factories and the diverse methods of using illuminants. The Committee has taken into consideration the codes adopted in certain American States, and the recommendations made last year by the German Illuminating Engineering Society. It will be noted that, in view of the fact that in some cases a readjustment of lighting will be necessary in order to comply with these requirements, a suitable time-limit, before these requirements become operative, is proposed for existing factories.

The proposals in this report thus carry the definition of adequate and suitable lighting a stage further. We feel sure that the desirability of such requirements in the interests of health, safety and efficiency will be generally endorsed, but it will be necessary to ensure that they are understood by managers of factories and others concerned. The Home Office has already taken steps in this direction by issuing a readable booklet explaining the principles of good industrial lighting, and the reasons why it is desirable, and we have no doubt that this explanatory pamphlet will be appreciated.

The question of the values of illumination, and the conditions of lighting desirable for various industrial processes remains to be dealt with, and we understand that the Committee proposes to investigate this matter with the co-operation of Industrial Councils, and similar bodies conversant with the technicalities of various trades. One point that deserves special consideration in this connection is that mere provision of certain values of illumination does not alone suffice to meet requirements. Classifications of lighting demands, according as rough, moderately rough, and fine work are undertaken, carry us a certain distance. But the position of the light with regard to the work, and the avoidance of inconvenient reflections or objectionable shadows, often demand very careful study, especially in the case of highly complicated and intricate machinery (such as is used, for example, in some sections of the textile industry). Ultimately each case of industrial lighting must be considered on its merits. When broad demands as regards adequacy have been met there remain many technical points to be considered in dealing with any particular industrial process, and in many cases we are at present far from having reached finality.

Throughout its work the Committee has adopted the wise procedure of making full use of available information published by the Illuminating Engineering Society and similar bodies on factory lighting. In dealing with the proceedings at the technical session of the International Illumination Commission in our last number, we mentioned that an international technical committee has been appointed to deal with school and industrial lighting, and the information to be collected in this way will doubtless prove of value in paving the way for further requirements. In the meantime, there is room for detailed study of the requirements in different classes of factories and we hope that investigations in this direction will be pursued by bodies concerned with illumination in this and other countries,

The Value of Lighting to the Gas Industry.

We are now approaching the period of the year when artificial lighting receives most attention. Conditions during the war had undoubtedly a depressing influence on some forms of lighting. All varieties suffered by the curtailment of outside lighting, but this hindrance has passed away and the present tendency is in the other direction. Many new lighting installations, held over during the war, should now be receiving attention, and although industrial conditions have had a certain restrictive influence there ought to be good opportunities for all illuminants. Other factors have, however, made themselves felt. Acetylene lighting during the war was overshadowed by the great demand for welding and other industrial applications. In the gas industry there has been a certain tendency to specialise on heating business, with a corresponding disregard, in some quarters, of lighting prospects.

In the present reconstruction period this tendency should surely be overcome. We recall that the *Gas Journal*, in May last, raised the question, " Is lighting worth keeping ? " and replied emphatically that it is. A properly balanced business includes a due proportion of consumption for lighting purposes. Heating demands depend upon atmospheric conditions and, as the present remarkable summer has shown us, the British climate can offer great surprises in this respect. Lighting, however, depends primarily on the period of darkness—a factor that is at least controlled by the time of the year and much less uncertain. Lighting, again, runs on when the industrial load has ceased, and cooking has greatly diminished, filling up what would otherwise be a period of comparative lack of demand. Finally, as our contemporary remarked, a lighting specialist is not merely a seller of lamps ; he possesses knowledge that can aid the consumer, and the friendly relations that he establishes, the good service that he renders, often lead to other important business.

We refer to this matter because, during recent years, there has apparently been a diminution in the amount of information appearing in the press dealing with gas-lighting developments, and we have found some difficulty in obtaining full information, such as is readily available in the case of electric lighting, on gas lighting installations. The same applies, in some degree, to other fields, such as acetylene lighting. There can be no doubt that many interesting installations of this kind exist and that the variety of applications of gas lighting will increase in the near future. We therefore take this opportunity of inviting gas companies and makers of gas appliances to put us in touch with information of this character.

Now that the crisis of the war and the abnormal conditions following it are passing away, we also look for new developments in gas lighting appliances. Recognising, as we do, the importance of gas lighting as a field of industry we feel confident that further progress in this direction will not be long delayed, and recent researches on radiation have shown that the advances theoretically possible are very considerable.

Light and Colour as Elements in Decoration.

The use of light in a decorative interior may serve two distinct purposes. It serves primarily to reveal the contents of the room. From this standpoint good lighting should be unobtrusive. One should only become aware that the room is well illuminated, from the fact that every object can be seen with ease and in comfort. Such defects as glare, imperfect diffusion and unduly hard shadows should accordingly be avoided, and the *colour* of the light also deserves consideration. Existing illuminants, as is well known, differ considerably in the quality of their light. In general they contain more of the red end and less of the blue and violet end of the spectrum than is present in natural daylight. The appearance of coloured objects, tapestries, carpets, coloured silks, china, enamelled ware, etc., is accordingly affected. In some cases—for instance, colour-harmonies involving blue, violet, lavender, and other complex shades—the natural charm of the object may suffer. Again, in the case of antique furniture, where a colour-contrast between the fabric and the colour of fumed oak or other wood is presented, distortion of colour-values by artificial light may prove a drawback.

Moreover, the natural colour of light yielded by an illuminant may be further altered by the use of tinted shades, or by the selective reflection of light from walls or ceiling. It must not be forgotten, therefore, that in respect of colour as well as brightness, anything incongruous should be avoided. Whether it is desirable, in rooms in houses containing choice coloured objects, to utilise "artificial daylight" for general lighting is a matter for discussion. But it seems likely that the local use of such units, to illuminate pictures, cabinets of china, etc., would often be helpful. In sections of stores displaying coloured goods the opportunities for the use of artificial light seem greater, because the best appearance of the goods is the most important consideration. Picture galleries also seem to present a case where general lighting by "artificial daylight" might well be studied.

From the standpoint discussed above, the appearance of the actual lighting unit (provided it does not draw attention to itself by incongruity with its surroundings) is of secondary consequence. But it may justly be argued that in many well-designed decorative schemes the lighting fitting plays an important part. It is, in fact, an essential part of the decorative scheme. This is recognised by the expert craftsman or decorator who selects fittings conforming with the distinctive style of the interior, and who tries to avoid such anomalies as the display of bare filaments or mantles, in a fitting of a period long before the arrival of gas and electricity for lighting. But there seems no reason why the existence of a source of illumination should be concealed. On the contrary the designer may, by the skilful use of brightness and colour, make it almost a dominating element which gives the finishing touch to the general scheme. However, in a room completely lighted by "artificial daylight," it might be argued that the resemblance to daylight should be completed by causing the light to appear through some form of artificial window. At present considerations of economy naturally limit the use of artificial daylight on a large scale. But the ultimate aim should be to imitate natural daylight, not only in colour but in the intensity and method of diffusion of the light as well.

L. GASTER.

THE INTERNATIONAL ILLUMINATION COMMISSION.

Summary of Proceedings at the First Technical Session held in Paris, July 4th–8th, 1921.

(*Concluded from p.* 178, *September issue.*)

Reports and Papers.

Primary Standards of Light.—A paper by Mr. E. C. Crittenden deals briefly with the historical development of the unit of light used in the United States. The American Institute of Electrical Engineers adopted a numerical relation between the English candle and the Hefner in 1903, and shortly afterwards, as a result of comparisons between standards of the national laboratories in Britain, France and U.S.A., it was decided to adopt incandescent electric lamp standards as a means of preserving the unit. The question of obtaining a suitable primary standard was deferred, and it was already assumed that the preservation of the *unit* and the design of a suitable primary *standard* were distinct matters. Meantime the 10 candlepower pentane lamp was introduced in America and used as a primary standard in the gas industry. Ultimately conferences between the chief national laboratories led to agreement on the use of a common unit, simply related to the Hefner candle, and now termed the "international candle."

Although the Hefner and Harcourt lamps reflect great credit on their inventors they involve elements of uncertainty. The Hefner lamp can be reproduced with facility, but the regulation of the flame, the weak light and its peculiar colour are difficulties. The pentane lamp is better in these respects, but unfortunately the differences in the light yielded by different lamps (often as much as 1 per cent.) are not negligible. There seems no reason to prefer this lamp to electric incandescent standards as the custodian of the unit of light.

Discussion on standards tends towards the definition of the unit of light in terms of energy radiated or properties of radiating substances, rather than special standard lamps. Various suggestions for the creation of a standard of light specified as a function of a flux of energy of prescribed quality have so far proved impracticable owing to limitations in methods of measuring absolute radiated energy. On the other hand, the properties of a black body, maintained at a specified temperature, appear promising. Recent researches in this field have applied to centimetre-cubes of black material and a mean brightness with prepared specimens has been determined within ½ per cent. From these and other experiments it appears that the brightness of a black body maintained at 2077° K. attains 70·2 candles per sq. in. It is very desirable, however, that confirmatory researches should be made with a view to ascertaining the degree of concordance attainable by different laboratories.

Specifications for Automobile Headlights.

Dr. C. H. Sharp presented the interim 1919-20 Report of the Committee of the American Illuminating Engineering Society (dated June, 1920) on the above subject. The Report covers: I.—Performance on the Road; II.—Laboratory Tests; and III.—Supplementary Regulations for Motor-car Headlights.

I.—Performance of the Road.

For the purpose of test the intent of the law governing the headlights of motor vehicles other than motor-cycles and tractors is deemed to be complied with if so adjusted, arranged and operated as to meet the following conditions:—

1. Any pair of headlamps under the conditions of use shall produce a light which, when measured on a level surface on which the vehicle stands at a distance of 200 ft. directly in front of the car and at some point between the said level surface and a point on a level with the centres of the lamps, is not less than 4,800 apparent candlepower.

2. Any pair of headlamps under the conditions of use shall produce a light which, when measured at a distance of 100 ft. directly in front of the car, and at a height of 60 in. above the level surface on which the vehicle stands, does not exceed 2,400 apparent candlepower, nor shall this value be exceeded at a greater height than 60 in.

3. Any pair of headlamps under the conditions of use shall produce a light which, when measured at a distance of 100 ft. ahead of the car, and 7 ft. or more to the left of the axis of the same, and at a height 60 in. or more above the level surface on which the vehicle stands does not exceed 800 apparent candlepower.

4. Any pair of headlamps under the conditions of use shall produce a light which, when measured on a level surface on which the vehicle stands at a distance of 100 ft. ahead of the car and at some point between the said level surface and a point on a level with the centres of the lamps and 7 ft. to the right of the axis of the car, is not less than 1,200 apparent candlepower.

II.—LABORATORY TESTS OF HEAD-LIGHTING DEVICES.

For the purpose of test representative samples of headlights are to be furnished by the State authority to the testing authority, with front glasses of 9 in. diam. when practicable. Reflectors are to be of 1·25 in. focal length and as nearly paraboidal as possible, and incandescent lamps are also to be of standard manufacture as approved by the National Bureau of Standards. Each device must bear a distinctive mark, and lamps must bear the manufacturer's normal clear bulb rating. The device, when tested, is to be adjusted in accordance with printed instructions issued by the manufacturer.

The nature of the tests is then prescribed. A pair of testing reflectors mounted similarly to the headlights of a car are set up in a dark room and fitted in turn with lamps of (1) vacuum type, 6—8 volts, 15 scp., and (2) gas-filled type 6—8 volts, 21 scp., adjusted to give their rated candlepower and efficiency. If a testing distance of 100 ft. is taken reflectors shall be 28 in. apart; for shorter distances proportionately nearer.

Test (1).—*6-point test of pair of samples.*

(A) In the median vertical plane parallel to the lamp axes on a level with the lamps, (B) in same plane one degree of an arc below level of lamps, (C) in same plane one degree of arc above level of lamps, (D) four degrees of arc to the left of this plane and one degree of arc above level, (E) four degrees of arc to right of this plane and level with lamps, (F) four degrees to left of this plane and two degrees of arc below level of lamps.

For points A and B the candlepower shall not be less than 4,800; for C not more than 2,400; for D not more than 800; for E and F not less than 1,200 at one of these points or some point between them.

Devices must comply with the above requirements in order to be recommended for certification; but if requirement could be secured with a lamp of higher candlepower than the values stated above, this fact shall be notified. The above instructions are based on the use of reflectors of 1¼ in. focal length. The testing positions and candlepower limitations will, however, govern all cases.

Test (2).—*Complete test of single sample.*

A single sample is to be submitted to a complete test with a vacuum type incandescent lamp of 15 candlepower, 6—8 volts rating, in order to determine light-distribution by the best laboratory practice.

One pair of samples shall be retained at the laboratory for future reference, and, as samples of construction, the other pair returned to the State authority.

III.—MOTOR-CYCLE HEADLIGHTS.

For motor-cycles carrying only one headlight the preceding sections are modified as follows :—

SECTION I.—Paragraph 1, instead of 4,800 candlepower, 2,400 candlepower shall be required; paragraphs 2 and 3 are unchanged; paragraph 4, instead of 1,200 candlepower, 600 candlepower shall be required.

SECTION II.—Instead of two pairs of samples one pair of samples is required, and Test 1 is made with a single lamp. Requirements of tests are modified in a accordance with alterations in Section I.

Reports, Reservation of Approval, etc.

Reports of tests are to be furnished in duplicate to the State authority and signed and initialled both by the expert making the test and by an executive officer of the institution making the test. Test 1 is designed to define a beam giving safe road illumination for driving at moderate speed under normal conditions of visibility. Approval may be refused to any device which, although conforming with the above requirements owing to unduly dark areas within the region specified for test, or from some other cause, is liable to prove unsafe. Approval may also be refused to a device which requires abnormal or unduly difficult adjustment, in order to comply with the above requirements, or which incorporates a design or mechanical construction which may reasonably be expected to prove unsatisfactory in practice.

Samples may be submitted to verification tests from time to time, and in the event of failure to comply with the specifications approval may be withdrawn.

NATIONAL PHYSICAL LABORATORY ANNUAL VISIT.

THE usual annual visit to the National Physical Laboratory took place on June 28th, when many interesting exhibits were on view. Of chief interest to our readers are the arrangements in the photometric section of the Electricity Department. Various forms of ships' navigation lights were on view and also a very powerful gas-filled lamp for lighthouse work rated at 8,000 candlepower—possibly about the highest value attained in practice with an incandescent electric lamp. We understand that lamps of this type consuming 4 kw. are being used for coast lights by the Dutch Government.

Among other exhibits in the laboratory may be mentioned the integrating sphere photometer and the apparatus for determining polar curves of light distribution. We had also an opportunity of inspecting the large cubical box with whitened interior which, it will be recalled, was recently used for tests of searchlight carbons. This appears to give a very fair measure of mean spherical candlepower, provided the distribution of light of sources compared does not vary too widely.

Finally it was of interest to observe the working of the spectro-photometer, which we understand is quite suitable for accurate comparisons of distribution of luminosity in the spectra of illuminants, such as are needed, for example, in studying "artificial daylight." The spectrum formed is adequately pure and the range of wavelength studied is precisely determined and adjustable. The line of division between the photometric areas is fine (a point that has not always received sufficient attention in the design of spectro-photometers). The adjustment of intensity is made by means of crossed nicols according to the tangent squared law. This appears to be now regarded as the most satisfactory method in instruments of this class.

THE LINKING UP OF GAS WORKS.

THE idea of linking up electric supply stations is a familiar one, and in a recent letter to the *Gas World* Mr. J. Mogford suggests that more ought to be done in this respect by gas undertakings. It is stated that last year the Ministry of Health appointed a "Regional Survey Committee" dealing, amongst other matters, with gas supply, and the trend of evidence favoured the linking up of existing works and concentration of manufacture. It was suggested by witnesses that gas supply should be dealt with by commissioners, and that any facilities given to the electrical industry should also apply to the gas industry.

SECOND REPORT OF THE DEPARTMENTAL (HOME OFFICE) COMMITTEE ON LIGHTING IN FACTORIES AND WORKSHOPS.*

It will be recalled that the above Committee was appointed by the Home Secretary in 1913 under the chairmanship of Dr. (now Sir Richard) Glazebrook. The first Interim Report (Cd. 8000) was issued in 1915† dealing generally with the lighting of factories. The work of the Committee was subsequently postponed until after the war and was resumed in 1920. Mr. C. D. Whetham was appointed chairman in succession to Sir Richard Glazebrook, who felt obliged to resign the chairmanship owing to pressure of other work. Professor Sherrington, Cd. F.R.S., has resigned from the Committee owing to his manifold duties, especially as President of the Royal Society. The present constitution of the Committee is as follows :—

Mr. C. Dampier Whetham, F.R.S. (Chairman), Mr. Leon Gaster, Sir Richard Glazebrook, K.C.B., F.R.S., D.Sc., Dr. C. S. Myers, C.B.E., F.R.S., M.D., Mr. J. Herbert Parsons, C.B.E., F.R.S., F.R.C.S., D.Sc., Miss R. E. Squire, O.B.E., Sir Arthur Whitelegge, K.C.B., M.D., Mr. D. R. Wilson, M.A., Mr. J. W. T. Walsh, M.A., M.Sc., and Mr. H. C. Weston, M.J.Inst.E., Joint Secretaries.

In what follows we give a summary of the contents of the Second Interim Report now issued by the Committee.

In an introductory statement the Committee recalls that in resuming work it was suggested that attention should be first directed to defining conditions necessary for securing suitable and adequate lighting, and inquiring into the effects of working in mixed natural and artificial light; also to classifying processes according to the minimum illumination required. Other matters since referred to the Committee include the best method of lighting glass-bevelling shops and the advisability of using translucent instead of transparent glass in factories. It was decided in the first instance to consider and report on conditions necessary to secure suitable artificial lighting, and on this certain requirements are now recommended.

In the First Report it was recommended that there should be a statutory provision :—

(A) Requiring adequate and suitable lighting in general terms in every part of a factory or workshop; and

(B) Giving power to the Secretary of State to make Orders defining adequate and suitable illumination for factories and workshops or for any parts thereof or for any processes carried on therein.

The opinion was expressed that the general statutory requirement of "adequate and suitable lighting" should include the observance of the following conditions :—

(1) Adequacy. (2) A reasonable degree of constancy and uniformity of illumination over the necessary area of work. (3) The placing or shading of lamps so that the light from them does not fall directly on the eyes of an operator when engaged on his work, or when looking horizontally across the workroom. (4) The placing of lights so as to avoid the casting of extraneous shadows on the work.

The Committee has now considered the conditions necessary to secure suitable artificial lighting, and the requirements recommended in the present report have been formulated with a view to their inclusion in an Order defining suitable lighting for all factories and workshops.

Attention has been given to the codes of lighting adopted in certain American States and to recommendations on industrial lighting formulated by the Illuminating Engineering Societies of America and Germany.

The present report deals only with the problems of suitable *artificial* lighting. Unsuitable systems of lighting are still common in factories and workshops. This condition has been accentuated by the extending use of high-intensity gas-filled electric lamps, which in many instances are used to replace tungsten

* Cmd. 1418. Obtainable from H.M. Stationery Office, Imperial House, Kingsway, London, W.C.

† ILLUM. ENG., Sept., 1915.

lamps in shades and reflectors intended for the latter. Generally speaking, one type of shade is adapted to one type of lamp only. To maintain suitable lighting, change of type of lamp often necessitates change of type or readjustment of the shade.

The requirements of suitable lighting are considered in the present report under the following three headings: (1) GLARE, (2) SHADOW, (3) CONSTANCY, in respect of which definite recommendations are made. Certain other factors have also been considered, namely: (i.) Diversity, *i.e.*, the ratio of maximum to minimum illumination. (ii.) Contrasts, due to difference of surface brightness. Further experiments may show that some regulation as to the surface brightness of any two visually contiguous surfaces may be required. (iii.) Colour and composition of the light.

On these three points, however, no definite recommendations are made at present.

(1) GLARE.

In the First Report the term *Glare* has been accepted as covering any of three phenomena, which are defined as follows:—

(1) The effect of looking directly at a bright source of light, such as an arc lamp, so that the observer is for the time being prevented from seeing other objects properly. He is temporarily dazzled and his vision is impaired for a short period after the light has ceased to enter his eyes.

(2) The effect which is produced by the presence of one or more bright sources of light towards the edge of the field of vision so that the rays enter the eyes obliquely from them. An observer may never look directly at such sources of light, but he is nevertheless troubled by their presence near to the object at which he is looking. This is the commonest form of glare.

(3) The effect which is produced when the surface of cloth, metal, paper or other material being worked upon is shiny or polished, and reflects light directly from some source into the eyes of the worker. Many satin cloths, for instance, have a "sheen" which causes work with such materials to be trying unless the worker is so placed with reference to the source of light that no rays can be directly reflected from the material into his eyes.

All three forms of glare are still to be met with in factories. The possible effects of the first two of these, which are most commonly due to absence of protection or to imperfect protection of the light sources, are twofold. Discomfort may be caused to the worker by the presence of a strong light in or near his line of vision, or a worker or other person entering a room may be temporarily dazzled by the light, so that he is unable to see his way about, and may incur additional risk of accident.

The first essential of suitability, therefore, is *proper* shading of the light sources. Many types of shades are now in use, and these vary considerably in efficiency. Some definition of the term "proper" shading seems, therefore, to be required.

Proper shading might be defined by prescribing a maximum brightness for the shades not exceeding a given number of candles per square inch. This method, however, involves complicated measurement. As a practical alternative, the Committee suggests, the simple criterion whether the incandescent filament, mantle or flame is distinguishable as such when viewed through the shade.

So far as glare is concerned, the source need only be screened when in or near the direct line of vision, and then only in the direction towards the eye.

In formulating a requirement on this basis two factors are taken into consideration:—

(i.) The distance of the source from the eye.

(ii.) The angle at which the light from an unscreened or improperly screened source may enter the eye without producing objectionable glare.

If an unscreened source is situated beyond a certain distance, which for all sources commonly employed in factories may be taken as 100 feet, its apparent size and the amount of light entering the eye will be so small as to render the glare effect much less evident. Such sources may be excluded from the requirement proposed. But at shorter distances between the eye and the source the influx of light from it will increase, and glare can then only be avoided by screening the source or by increasing the angle between the central line of vision and the source.

It is therefore suggested, that in practice a suitable requirement might be expressed in terms of the distance of the source and of a limiting value of the angle between the line from the source to the eye and a horizontal plane, within which angle no such source should be directly visible. In the case of sources used for general lighting an angle of 20 degrees is deemed sufficient for the purpose of legal requirement, but for near sources, such as are used in local lighting, an angle of 30 degrees should be substituted. The Committee accordingly recommends a provision as follows :—

(A) . . . **"Every light source (except one of low brightness*) within a distance of 100 feet from any person employed shall be so shaded from such person that no part of the filament, mantle or flame is distinguishable through the shade, unless it be so placed that the angle between the line from the eye to an unshaded part of a source and a horizontal plane is not less than 20 degrees, or in the case of any person employed at a distance of 6 feet or less from the source, not less than 30 degrees."**

The third form of glare (*i.e.*, reflected light or polished material is used), and may be remedied either by changing the position of the source relatively to the eye, or by enclosing the source in some diffusing material. The following simple requirement is proposed :—

(B) . . . **"Adequate means shall be taken, either by suitable placing or screening of the light sources, or by some other effective method, to prevent direct reflection of the light from a smooth or polished surface into the eyes of the worker."**

(2) SHADOW.

Troublesome shadows are generally due to unsuitable placing of the light sources, whereby the shadow of the worker himself or of some part of the plant or material is cast on the place of work, and are particularly objectionable when thrown by some object in motion. Apart from the annoyance caused and the interference with the proper execution of the work, deep shadows, by concealing dangerous parts of machinery, may lead directly to accidents. The Committee recommends therefore, that there should be a provision as follows :—

(C) . . . **"Adequate means shall be taken to prevent the formation of shadows which interfere with the safety or efficiency of any person employed."**

(3) CONSTANCY.

Constancy in artificial illumination is of great importance. Unsteadiness and flicker have an injurious effect on vision, and if pronounced, increase the risk of accidents. Under modern conditions, and with a modern system of lighting, this detrimental factor is unlikely to arise. There are factories, however, in which old-fashioned batswing burners are still in use (apart from instances where they are deliberately employed for special reasons, *e.g.*, on boring machines), or in which incandescent gas mantles are inadequately protected from draughts. Similarly in some electrically lighted factories flicker and variation in illumination may arise through fluctuations of the voltage available. Such fluctuations may possibly arise through the employment of alternating voltages of low periodicity.

The Committee remarks that flicker which can be remedied should be prohibited, and accordingly recommends the following provision :—

(D) . . . **"No light sources which flicker or undergo abrupt changes in candlepower in such manner as to interfere with the safety or efficiency of any person employed shall be used for the illumination of a factory or workshop."**

Taking into account that extensive alterations may be necessary in many factories to comply with the requirements suggested the Committee make a final recommendation :—

(E) . . . **"That, as regards existing installations, a reasonable time limit should be given before the above requirements become operative."**

An Appendix to the Report contains extracts from various Codes of American States bearing on the above points, and also a summary of the recommendations recently made by the Illuminating Engineering Society in Germany (See ILLUM. ENG., Oct.-Dec., p. 275).

* By "low brightness" is meant an intrinsic brilliance of not more than five candles per square inch.

THE PRINCIPLES OF GOOD INDUSTRIAL LIGHTING.

IT has often been remarked that regulations bearing on industrial lighting require to be supplemented by readable explanations of the principles adhered to, and the best means of carrying them out in practice. It is therefore of interest to observe that, in a recent Welfare Pamphlet, issued by the Home Office,* a valuable exposition of the fundamental principles of good industrial lighting is given.

In some introductory remarks on the importance of lighting, the reports of the Departmental Committee on Lighting in Factories and Workshops are mentioned. It is remarked that lighting is only satisfactory provided (a) that there are no lighting conditions prejudicial to the health, comfort and safety of workers, and (b) that it is sufficient for the proper carrying out of work both as regards quality and output.

Under the heading "Fundamental Requisites of Good Lighting" the conditions implied under the description of "adequacy and suitability" (*i.e.*, sufficient illumination, constancy and uniformity, prevention of glare and avoidance of inconvenient shadows) are explained and the recommenaations made in the reports of the Departmental Committee are summarised. Natural and artificial lighting present distinct problems; attention to the former is the more desirable in that it avoids unnecessary expense in the form of artificial lighting. As regards methods of artificial lighting the distinctions between general and local lighting, direct and indirect lighting, are explained and the advantages of each are discussed. One of the most useful portions of the booklet is doubtless that dealing with the Causes of Unsatisfactory Lighting. In regard to natural lighting such simple but effective practices as the frequent cleaning of window, the avoidance of obstructions to light, and the maintenance of light colours on walls and ceilings in order to secure diffusion, are pointed out. In connection with artificial lighting we meet the defects of provision of too few or too weak sources, antiquated methods of lighting and inadequate supply of gas or electricity, bad placing of lights, inadequate maintenance, etc.

Next the illumination required for the execution of work is discussed, attention being specially directed to the fact that dark materials require a correspondingly increased illumination. Finally the various principles outlined in the foregoing part of the booklet are presented in the form of a series of concise queries, the page where information is afforded being indicated in brackets after each question. The booklet is illustrated by effective photographs showing good and bad local lighting of a lathe and the illumination, by well-shaded gas lights, of the composing frames in a large printing works. An Appendix deals briefly with the measurement of illumination, as an essential process in ensuring adequacy of industrial lighting.

* Lighting in Factories and Workshops, Welfare Pamphlet, 1921, No. 7. 4*d*. net. Published by H.M. Stationery Office, Imperial House, Kingsway, London, W.C.

Obituary.

O. P. MACFARLANE.

We regret to record the death, on August 25th, of Mr. O. P. Macfarlane, a Member of Council of the Illuminating Engineering Society from its commencement. Mr. Macfarlane was associated with Blanchard (British) Lamps, Ltd. He took a keen interest in the work of the Illuminating Engineering Society, to which he rendered good service on many occasions.

CHAS. W. HASTINGS.

We learn with regret of the death, on September 28th, of Mr. Charles William Hastings, at the age of 71. Mr. Hastings was closely associated with the early developments of the Illuminating Engineering Society, and took a prominent part in technical journalism, being Editor of the *Gas Engineers' Magazine* and connected with various other journals.

Mr. Hastings had a genial disposition and varied interests, and had many friends in the lighting industry.

SOME IMPRESSIONS OF THE SHIPPING ENGINEERING AND MACHINERY EXHIBITION.

By AN ENGINEERING CORRESPONDENT.

THE Shipping Engineering and Machinery Exhibition held at Olympia during September 7th—28th contained much of interest. It is necessary to confine oneself primarily to lighting matters, but these covered a wide field. The lighting of exhibitions has often been the subject of comment. On this occasion one received the impression that the general standard was better than in some past exhibitions, relatively few examples of stalls quite incorrectly lighted being seen. In some instances quite sound methods were used and ingenious artifices adopted. Thus the exhibit of Bulkhead Smoke Box Doors, Ltd., just inside the entrance was simply but agreeably lighted by lamps concealed in inclined metal reflectors facing the contents of the stall. The stalls of exhibitors who specialise in lighting were naturally adequately lighted. Thus the British Thomson Houston Co., Ltd., used a variety of overhead industrial fittings, Messrs. Siemens Bros. & Co., Ltd., adopted semi-indirect methods, while the Metropolitan Vickers Electrical Co., Ltd., in addition to overhead lights, adopted a series of lamps with frosted bulbs round the edge of the stall, the name of the company being spelled out by black letters stencilled on the bulbs. Jas. Walker & Co., Ltd., in their exhibit of packings and other specialities, used the approved method of concealing lights behind a translucent fascia, allowing the light from the concealed lamps to illuminate the goods.

Luminous signs were used with effect in some cases. Thus Messrs. Babcock & Willcox adopted an "Internalite" flashing sign of the type recently shown by Mr. E. T. Ruthven Murray before the Illuminating Engineering Society, and similar signs were utilised by some exhibitors in the galleries. On the other hand, Messrs. Campbell and Isherwood used a letter sign composed of the new neon lamps, in which electrodes consist of metal letters surrounded with a luminous orange glow. Messrs. Swan, Hunter and Wigham Richardson had some effective pictorial illuminated signs showing the trade ship "British Industries," and a complete model, in an illuminated case, of the "Mauretania"—both vessels for which this firm is responsible.

A feature was the effective use by some exhibitors of positives of photographs, backed by diffusing glass and illuminated from behind—a method which is much more striking than the use of ordinary photographic prints. The British Thomson Houston Co., Ltd., had on view several large views illustrating the application of electricity to ship-propulsion and the lighting of ship-yards, arranged as box signs, while other illuminated photographs were devoted to views of factory lighting, etc. Yarrow & Co. also made effective use of illuminated positives of ships constructed by this firm. These displays were in striking contrast to those of another exhibitor, who mounted framed photographs round the roof of the stall, and provided a series of naked glow lamps in front of them for the purpose of illumination!

Ship and Dockyard Lighting Fittings.

Electric lamps and lighting fittings were shown by a number of firms, in some cases serving as exhibits of units for ship or shipyard lighting, and also contributing to the illumination of the stall. The three electric firms named above showed a variety of fixtures and cases of standard vacuum and gas-filled lamps. The British Thomson Houston Co., Ltd., adopted the device of showing typical saloon and other ship-fittings alight, with a painted background illustrating their use in practice. Special Mazda navy bulb lamps, flood-lighting projectors, weather-proof dock lanterns and mazdalux reflectors were also shown. The Metropolitan Vickers Electrical Co., Ltd., besides a set of Cosmos lamps, exhibited the "low-clad" system of ship-wiring, the "single operator" welding

generator and other specialities, while Siemens Brothers & Co., Ltd., had a series of indicating instruments of various kinds, including the familiar indicator serving to show in the charthouse when any navigation light failed to operate.

The Engineering & Lighting Equipment Co., Ltd., had also a varied series of lighting units for ships, docks, collieries, etc., a special feature being the exhibit of the "anti-break" electric economiser, which involves the support of the lamp-holder by a series of radial phosphor bronze strips. With small fittings a single radial disc of this description suffices; with heavier fittings two or more discs may be used. A demonstration of the effect of the disc was given by arranging in a box, faced with coloured glass, a lamp thus supported and another lamp mounted direct without any shock-absorbing device. Visitors were invited to test the appliance by thumping the top of the box and observing the effect on the respective lamps.

A fitting of special interest was that recently adopted for use on submarines, in which the lamp-filament is completely screened from the eye by a small cup, mirrored internally and white on the outside, which directs light on to an overhead shallow reflector. We understand that in submarines, owing to the long periods during which the men are confined in artificial light, avoidance of glare is considered particularly desirable; this lighting unit has, however, also industrial uses.

Wm. McGeoch & Co., Ltd., supplemented their exhibit of ship-fittings by a model of a cabin showing their use in practice. This firm also exhibited their duplex indicator giving an audible signal in the event of either of the navigation lights failing. Another device shown was a box with an opal glass lid, illuminated from below, bearing a set of letters of the alphabet with the appropriate Morse signal. Among other firms who exhibited fittings and ships' lights, both electric and oil, may be mentioned G. Welford & Sons, Ltd., the Carron Co., Ltd., and Nettlefold & Sons, Ltd.

Searchlights.

One of the chief exhibits in this field was that of the London Electric Firm, who showed a great variety of arc-searchlights including a Suez Canal type, a 16 in. pilot house type, and a 10 in. signalling projector with Louvre pattern shutter. It was also interesting to see examples of flood-lighting projectors (using gas-filled incandescent lamps), which can be mounted on tripod or bracket, and seem likely to have useful applications on board ship for facilitating the unloading of cargo at night, etc. The Allen-Liversedge Co. had on view both oxy-acetylene landing lights for aeroplanes and electric searchlights. Messrs. Clarke, Chapman & Co. also included searchlights in their exhibit, and the Sperry Gyroscope Co., in addition to the well-known gyro-compass, showed the Sperry searchlight, which excited so much attention during the war in view of the gain in range attributed to the use of a cooling blast with the electrodes.

Acetylene, Incandescent Oil and Other Illuminants.

It is generally recognised that self-contained and portable illuminants have a distinct field for emergency lighting on board ships, and also on docks, etc. Acetylene plant was naturally in evidence at the exhibitions, being shown by the Allen-Liversedge Co., Ltd., Carbec Ltd., Thorn & Hoddle Acetylene Co., and others. In addition to the use of acetylene for lighting, auto-acetylene welding processes play a great part in ship-repairs, and demonstrations were given by the above firms. These demonstrations were conducted behind sheets of coloured glass enabling the process to be witnessed with comfort by spectators. A feature of the lighting section was the display of semi-indirect and silk-shaded acetylene fittings and of various types of hand lamps and flare-lights suitable for use by contractors, dock companies, etc. A factor of some importance from the marine standpoint is the "stiffness" of the acetylene flame, which enables it to withstand considerable wind-pressure, and is taken advantage of in the so-called "hurricane lamps." A feature of the Allen-Liversedge exhibit is the fact that the firm supply either acetylene, petrol-air gas, or electric plants for

country use. For small plants it is believed that in general the running costs of the three systems are not widely different, but local considerations may decide the choice. Sometimes, for example, an independent petrol-air gas plant may be installed for heating, in view of the fact that the range so closely resembles an ordinary gas one, whereas cooking with acetylene may at first present unfamiliar features.

Incandescent self-contained oil lamps were represented at the stall of the Kitson Empire Lighting Co., Ltd., one interesting type being the "Cooklite," which can be used as a cooker but rapidly converted to a lamp if desired. This firm also showed a "Speedlite" petrol gas table lamp which is claimed to be extremely simple and safe, and to burn in any position, and the "Kelite" brazing and blow lamps, which, it is stated, were formerly exclusively made abroad, but have been developed in this country since the war.

Electric Welding Plant.

While not falling within the ordinary lighting field the exhibits of electric welding plant deserve a word of mention in view of the great progress made in this field during recent years. Among other firms exhibiting were the Alloy Welding Co., Ltd., the British Arc-Welding Co., Ltd., and Messrs. Buckley, Saunders & Co., Ltd. The Alloy Welding Co. showed an interesting new type of plant using alternating current at only 50 volts, and demonstrated the use of wire-welding and the treatment of tramrails. Buckley, Saunders & Co. exhibited their "Cyc-arc" machine for attaching metal studs, tubes, etc., to iron plate, resistance welders, rivet-heaters, butt-welders and other appliances.

Miscellaneous Exhibits.

Electric plant for use on board ship and lighting sets were shown by a considerable number of firms, the "Aster-British Light," a semi-automatic country house plant, being one of many units shown by this firm. Small 1—1¼ k.w. lighting sets were a feature of the Vickers-Petters exhibit, while the London Electric Firm had an extremely small and compact petrol-driven set of the "Bungalite" type.

An exhibit of considerable interest at the stall of the Engineering & Lighting Equipment Co. is the new Grubb anti-dazzle headlight, which, we understand, is now being developed in quantity. The headlight utilises two "D"-shaped lenses separated by a strip of grooved glass, and the whole enclosed in a 10 in. tapering tube. Light is reflected from a special mirror behind the electric lamp, but the effect of the lenses and the dividing grooved plate is to concentrate the light mainly below the horizontal, with quite a sharp dividing line at a height of about 4 ft. above the ground. Thus, according to the R.A.C. certificate the range was a maximum (227 ft.) at 3 ft. above the roadway, had diminished to 185 ft. at 4 ft., and to only 36 ft. at 5 ft., after which the light diminishes still further. The headlight thus aims at carrying out the requirement, now recognised as desirable, of providing a powerful beam below a certain level, but avoiding dazzle to the eyes of pedestrians or drivers of other vehicles by inconvenient upward rays. According to the R.A.C. test quoted there appears to be practically no diminution in range within a distance of 15 ft. on either side of the axis of the beam. The headlight thus appears to have interesting features, and its development will be closely watched.

The "Electro-automate" lamp specialities exhibited by Theo & Co. have the attractive feature of being independent of the dry cell ordinarily used with pocket torches, the current being provided by magneto-dynamos, contact screws, carbon brushes and commutator, etc., being eliminated. The pocket type of lamp is worked by a lever rack and gear wheels furnishing 2½—3 volts and has a weight of 12 oz. A larger type weighing 24 oz. is also provided, while a third signalling type is mounted on a tripod and operated by the foot. There is also a special laryngoscope outfit for the use of medical men. The idea of dispensing with batteries and using a hand-driven generator for such lamps has only been developed during recent years, and such apparatus certainly seems to deserve

attention. In conclusion mention may be made of the current-indicator by which the current consumed by an installation is automatically kept within prescribed limits, which is exhibited by Electrical Utilities, Ltd. This is proposed as a convenient apparatus for use in housing schemes, etc.

SILK SHADES AS DIFFUSERS OF LIGHT.

So much attention has been given to lighting glassware during recent years that the utility of the silk shade has hardly received sufficient attention. Admittedly one may not obtain such complete control of the distribution of light, but there are compensating advantages, and the silk shade is not necessarily an unduly wasteful device in its own field.

Among its advantages are the complete concealing of the light-source, so that practical identical results are obtainable with electric, gas, acetylene and other illuminants. The soft and mellow light obtainable, and the decorative possibilities in regard to colour make the silk shade a valuable adjunct in domestic lighting, in restaurants and in some places of entertainment. It has a peculiar merit as regards adaptation to schemes of decoration. Hand-painted shades harmonising with wall-paper, carpets and furniture can be obtained ; shaded lamps over a dining room table may be ingeniously adapted to special decorative effects on festive occasions.

One can recall protests by lighting experts against smothering electric lamp bulbs in thick crinkled paper, and certainly the indiscriminate use of deeply coloured material more or less completely covering the lamp leads to great loss of light. In the case of prismatic or other light-diffusing glassware one may preferably use a silk shade as an outer cover, thus gaining good efficiency as well as decorative effect. Another objection to the use of heavily shrouded lights is that the room is then illuminated by highly tinted light which may play havoc with the appearance of coloured objects.

A point of obvious concern to the lady of the home is the problem of keeping shades clean. Experience of showrooms shows, however, that silk shades can be kept in stock for a considerable period if cleaning is carefully attended to. As hand-painted and artistically executed shades may be valuable this is an important point.

One means of avoiding cleaning trouble is the enclosure of coloured silk patterns between two glass dishes forming a semi-indirect unit, or alternatively their insertion between straight glasspanes in a lantern. Being thus enclosed they are not liable to attract dust and can be easily changed at any time.

INSTITUTION OF GAS ENGINEERS.

ANNUAL GENERAL MEETING.

At the Annual General Meeting of the Institution of Gas Engineers, held during October 11th and 12th, a congratulatory address from the Institution was presented to Mr. Samuel Glover, Past President, on the attainment of 50 years' service in the St. Helens Gas Undertaking.

In addition to the Council's usual Annual Report, reports of the Gas Investigation Committee (on Recording Gas Calorimeters and Blue Water-Gas) were discussed and a report on Refractory Materials presented by Mr. A. E. Broadberry.

Among other items we observe papers by Sir George Beilby on "Steaming in Vertical Gas Retorts," and by Mr. G. M. Gill on "Carbonisation in Horizontal Retorts."

Other papers include : "Tar Distillation and Sulphate of Ammonia Manufacture," presented by Alderman F. J. West ; "The Liberation of Nitrogen from Coal and Coke as Ammonia," by A. C. Monkhouse and Prof. J. W. Cobb ; "The External Corrosion of Services and Mains," by J. G. Tapley, and the "Report of the Life of Meters Committee," to be presented by the President.

We have also been favoured by a copy of the comprehensive report on the proceedings at the International Commission on Illumination in Paris, to be presented by Mr. Robert Watson, of Doncaster.

SOME NOTES ON GAS LIGHTING.

By an Engineering Correspondent.

During the period of the war, when so much prominence was given to the applications of gas for heating, especially in munitions works, developments in lighting were somewhat overshadowed; indeed, all forms of lighting unavoidably suffered some degree of restraint. At the present time, however, matters are different. Despite the present industrial depression there is much lighting work to be shared by the various illuminants, and each has its prescribed field.

Rating in Terms of Calorific Power.

In the field of gas-production one of the most notable events of recent years, which was doubtless hastened by war-time experience, is the general adoption of calorific value and the sale of gas in "therms." This is doubtless a more logical method than the sale of gas in terms of cubic feet, irrespective of calorific value. A further logical development has been already proposed by the Illuminating Engineering Society in the United States and may become usual in this country, namely, the rating of lamps in terms of candles per B.Th.U. per hour.

Apparently most companies now aim at producing a gas of about 450 B.Th.U., though there is still some argument as to what is the best value. Mr. C. B. Tully, for instance, advocates in the *Gas Journal** a lower value, in the neighbourhood of 350-375 B.Th.U., as giving the maximum therms per ton of coal. He remarks that with the present calorific values the highest efficiency in the gas lamp can only be obtained by using high pressure gas. What Mr. Tully aims at producing is a gas that can be burned "straight" by the consumer without a bunsen burner or admission of primary air. Now that quality of gas can be adjusted concurrently with burner design, new possibilities are opened up. The rich field for investigation in gas lighting is particularly promising, as there are so many factors, variety of gas, burners and mantles, all of which are doubtless capable of improvement. It may be recalled that H. E. Ives, E. F. Kingsbury and E. Karrer, in a physical study of the incandescent mantle some years ago,† reached the conclusion that by proper selection of materials for the mantle and suitable design of the burner, it was possible theoretically to attain a luminous efficiency of 2·6 per cent.—thirteen times that attained at present with the normal mantle. Even this figure, however, is still low from the standpoint of absolute efficiency (being in fact less than that reached in the electric gas-filled lamp). The theoretical margin for further improvement in efficiency is thus apparently very large—and the fact that it is so large gives promise of great future advances in gas lighting.

As regards the effect of a change of quality of gas on the performances of burners already installed, it is to be assumed that a gas company would not alter the quality of gas to an extent that would demand a radical change in the design of burners in use; the existing latitude of regulation on burners should accordingly suffice to enable them to work well under the new conditions. In cases where gas of a constant quality and uniform pressure throughout a district can be secured, as in the instance of the South Metropolitan Gas Co.'s district, it is practicable to provide burners with fixed adjustment, that requires no attention in this respect from the consumer. The possibility of ultimately providing standard burners without adjustment for use throughout the entire country has been discussed, but it seems to be generally agreed that, in view of the present variations in calorific value and pressure in different districts, this step is at present impracticable.

The outbreak of hostilities in 1914 naturally gave rise to various perplexities. The extreme inconvenience that was caused in the early stages of the war by the stoppage of mantles from abroad,

* October 5th, 1921.

† Journal of the Franklin Institute, 1918.

and the withdrawal of supplies of ceria and thoria and other materials needed in mantle manufacture, is now a matter of past history. Prior to the war it was estimated that not more than a quarter of the mantles used in this country were home manufactured. The absence of the imported article naturally favoured the development of the mantle industry in this country, and the experience gained will doubtless be of value in the future. Meantime, it is interesting to observe that the German mantle manufacturers had their troubles. While the shortage of materials in this country was gradually remedied, the corresponding difficulties in Germany became progressively more acute. In this country there was freedom to import such materials as ramie fibre and asbestos and the sands of Travancore and elsewhere whence thoria and ceria are extracted. The chief problem was to multiply existing facilities for production and achieve the necessary chemical treatment in bulk of the sands. But according to an article by Dr. Geisel in the *Journal für Gasbeleuchtung*, German makers were, after a time, unable to import most of the essential materials, almost all derived from abroad, and had to rely on the existing stocks, or find substitutes. The cost of a mantle was estimated to consist two-thirds of material and only one-third of labour, and soon became almost prohibitive. Ramie yarn was unobtainable, artificial silk mainly controlled for war purposes. Ultimately fabric composed of paper, free of inorganic material, had to be used, the light yielded being only 60-70 per cent. of that from Ramie mantles. Asbestos, again, was derived from abroad, and after existing stocks had been used to the utmost, mantles were suspended by means of iron wire.

Inverted Mantles and Cluster-Lamps.

For many years there has been a progressive tendency towards the use of inverted mantles in place of those of the upright type, on account of their more robust qualities and the higher luminous efficiency attained. Probably in almost every new installation inverted mantles would now be used. The conversion of existing upright fittings to the inverted type, however, presents interesting problems. In many cases consumers prefer a fitting that emerges upwards out of its base, and in others an obvious conversion of, say, a ring fitting to the inverted type appears unsightly. Accordingly the idea has been developed of bringing up a central outlet leading to and bending over to two or more small inverted mantles surrounding it. If the inverted burners are confined within a vitreosil or other diffusing translucent cylinder the appearance to the eye is precisely that of an upright fitting, but at the same time the advantages of the inverted mantle are secured.

Gas fittings are now designed to resemble very closely certain types of electric light units. For instance, a series of inverted mantles can now be mounted within a diffusing bowl, capable of being placed within a few inches of the ceiling and closely resembling the conventional electric bowl ceiling unit. The access of air and the removal of products of combustion are so cunningly contrived that at first sight the fittings appear completely sealed. Semi-indirect pendant fittings carrying a group of mantles have also reached a further stage of development and it is surprising that this form of gas lighting is not more widely used. At one well-known railway station the writer recently observed a case of quite effective semi-indirect lighting in the restaurant. The waiting-room next door, however, was lighted only by a simple T-fitting with mantles in clear globes at its extremities, and presented an unfavourable contrast.

The idea of cluster-lights, which is naturally associated with semi-indirect lighting, is a comparatively new development of great interest. The replacement of a few big upright, or even inverted, mantles by a larger number of small ones has been found to have several advantages. The smaller mantles are stronger and more efficient, and experience appears to show that the cost of maintenance is actually less than with the smaller number of big mantles. Other advantages are that the failure of a single mantle makes relatively little difference to the light yielded by the entire unit; also that individual mantles can be

separately controlled, if desired, so that the total light yielded can be modified in the same way as a multiple-lamp electric light fitting is controlled by switches. In some fittings as many as sixteen mantles are assembled. The utilisation of a ring of mantles in a central ventilating light, which became popular in the years preceding the war, seems now to be again coming into favour.

Another quite recent interesting development is the general use of the vitreosil heat-resisting glassware. Prior to the war small silica-globes had been utilised with high pressure gas lamps, for example outside the National Gas Exhibition in 1913. But the application of cups, bowls and globes of this material to low pressure gas lamps is comparatively new. From a lighting standpoint the globes have several advantages. Owing to their heat-resisting properties they can be brought quite close to the mantle so that the unit assumes a neater and more compact appearance. Their durability is said to be such that, notwithstanding their higher initial price, there is a saving on maintenance costs.

But another quality of interest from the illuminating engineering standpoint is that the material is translucent but not transparent, and thus acts as a diffuser of light, with the result that the mantle itself cannot be seen. It is also noticeable that the colour of the light is changed to an appreciably warmer and, to the writer's taste, a more agreeable tint. In fact, as the actual mantles are invisible it is not so easy at first glance to say whether some units enclose electric filaments or gas mantles. The absorption of light involved is of no great moment; it is stated, indeed, that the gain in efficiency arising from the high temperature permissible with this form of glassware goes far to compensate for such absorption, and that in some cases there may actually be a gain in efficiency.

"Parade" and Shop Lighting.

Another development which was checked by the war, but is now again coming into its own, is the so-called "parade-lighting," *i.e.*, the intense lighting of important sections of streets occupied by large stores. One of the most spectacular examples is the well-known display in the Lewisham High Road, though there are many other instances in Tottenham and elsewhere. This mode of lighting probably forms the nearest approach to the "white-way" systems developed in the States. In the future one may anticipate a development making the resemblance still closer, *i.e.*, the use of a series of lamps on single standards, the mantles being enclosed in diffusing or special ornamental globes. Lamps immediately overhanging shop-windows serve a similar purpose. Care should, however, be exercised to avoid glare from high-pressure lamps so used, and the most effective examples of external window lighting are doubtless those in which the lamps are effectively screened from the eyes of persons viewing the contents of the windows by suitable parabolic reflectors.

In regard to high pressure factory lighting a development of interest has been the "duct" system applied to Keith lamps installed in a rubber factory during the war, whereby tubes containing fresh air are led into the building from outside and the high pressure gas coupled up at various points, each connection supplying, by means of one injector, a number of high pressure burners. One advantage is that the injector, being of large capacity, is not liable to get choked. The leading in of fresh air from outside also avoids the difficulty of introducing into burners a dust-laden air from inside factories, which is apt to prove a trouble when the processes carried on give rise to suspended particles in the atmosphere.

It is interesting to observe* that the National Gas Council has recently recommended, for insertion in the new Model Gas Bill, a clause insisting on the provision of an efficient non-return valve for preventing the admission of high pressure air to service pipes or mains through which gas is supplied, a precaution which already appears in the Order of the Spenborough Urban District Council.

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* *Gas Journal*, Sept. 28, 1921.

TOPICAL AND INDUSTRIAL SECTION.

[The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona-fide* information relating thereto.]

EDISWAN INDUSTRIAL LIGHTING.

A catalogue recently issued by the Edison Swan Electrical Co., Ltd., dealing with industrial lighting, has several interesting features. We are glad to observe that special attention is given to the use of illuminating engineering methods. After a brief summary of the fundamental principles of good industrial lighting a series of definitions and a table of values of illumination for various processes is provided, and some hints on the calculation of illumination, based on the lumens available from various lamps, are given. Next reflectors are discussed, a variety of Holophane, Ediswan, Wardle and Benjamin types being illustrated. Illustrations of typical lanterns and semi-indirect fittings are also provided, and there are some effective photographs of industrial and shop-lighting installations.

PIFCO SPECIALITIES.

A catalogue issued by the Provincial Incandescent Fittings Co., Ltd. ("Pifco"), of Manchester, contains several features of interest, notably the P-A-L white enamel wire gas globes, which are claimed to be practically unbreakable. As the name suggests, the globe consists of finely woven enamelled wire and forms an effective protection against possible danger from falling particles of mantles or hot accessory parts. The globes are made in a great variety of sizes and shapes, some being of quite compact dimensions.

The effect of such globes on the light raises interesting problems. The mantle is visible through the web, and doubtless light is reflected off the white surface of the wire. It would, however, be interesting to have figures comparing the light emitted through such globes in comparison with clear and diffusing glass. Silk shades and semi-indirect fittings for gas are also illustrated. We also notice illustrations of public lighting burners, comprising two-light clusters with pre-heated gas mixing chambers and typical outdoor cluster lamps.

The firm does not confine itself to gas lamps, however, but also supplies electric glow lamps and incandescent paraffin lamps in variety.

LISTER-BRUSTON AUTOMATIC ELECTRIC LIGHTING PLANTS.

During the war comparatively little could be done with country house lighting, many firms who ordinarily devoted themselves to such work being engaged on munitions. Now, however, matters are different, and there should be a good demand for reliable automatic plants for country houses, factories, and villages where neither gas nor electricity is available.

A leaflet issued by R. A. Lister & Co., Ltd., illustrating the "Lister-Bruston" electric lighting plant, records a list of distinguished users. The plant involves a dynamo driven by a small petrol engine; if necessary, however, town gas can be used instead of petrol to drive the engine. A feature is the automatic action. The engine is stated to start and stop itself, as need requires, without attention. Only a small battery (about one-fourth to one-fifth of the size required for the whole load) is used. The battery alone will supply current for a small load of 5—10 per cent.; for greater loads the engine starts automatically and takes up its share of the load, also keeping the battery charged. Thus the advantages both of a generator and a battery system are secured.

A variety of plant is illustrated and particulars of cooking outfits, pumps, etc., are given.

MOONSTONE ILLUMINATING GLASSWARE.

We have received from Underwood (Manchester), Ltd., a catalogue of "Moonstone" scientific illuminating glassware of which a variety of decorative types are shown. These include bowls and semi-indirect fittings of moulded diffusing glass. Local lighting is exemplified by the "Verdelite" desk and table standards, some of which have a compact and pleasing appearance. Other items include trough reflectors suitable for show window lighting and ornamental standards, carrying diffusing globes on the "Whiteway" system, which is familiar in the United States, but is at present not widely used in this country.

"LUMINOR" SIGNS.

AT various times efforts have been made to design lettered signs, which collect the light falling on them, whether natural or artificial, and accordingly "stand out" with a highly luminous appearance by night or day. The economy of such a device needs no demonstration. To secure a striking appearance in diffused daylight is probably comparatively easy, but it is evident that a device that effectively collects the relatively small amount of scattered artificial light available in many streets by night requires careful design.

We had recently an opportunity of witnessing the device now being introduced by Luminor Signs, Ltd., of 35, Sackville Street, London, and of inspecting the actual manufacture of the signs at the firm's factory. In its usual form the sign consists of lettering (which may be in capitals or follow any distinctive advertising script) outlined on a wire-strengthened cement frame-work, by embedded convex mirrors. Letters commonly vary in size from 3 to 24 inches, discs of progressively increasing diameter being used according to the dimensions of the letter. The illustration gives an idea of the effect produced. The polished convex mirrors focus rays of light falling upon them and become brightly luminous points of light. It is stated that they can deal with rays coming from a great variety of angles, though naturally when they are used at night time some positions may be more effective than others. We were shown some signs, however, which certainly stood out effectively in a very feebly lighted interior, and of course in any special case where there is a likelihood of insufficient artificial light being available it is always possible to install a light in a convenient position to enhance the effect; even so, the consumption of electricity would be relatively small.

A question that naturally arises is the permanence of the sign when exposed to weather. For outdoor work concrete frames are preferred, the final frame being made from a gelatine mould cast from a plaster of Paris model. For indoor work, however, it may suffice to work with a plaster of Paris or wood shape direct, thus saving expense. The embedding of the mirrors must be done with special care with a view to avoiding any possible prejudicial effect of the entry of moisture. We understand that the idea is now being developed of making each separate mirror a detachable piece, terminating in a screw holder, so that the owner of a sign can himself replace any individual

Showing method of applying Luminor Mirrors in a warning sign for motorists.

disc which may show signs of wear. Apart from their ordinary use as signs for the purpose of giving information or warning, or acting as advertisements, the mirrors may have other special uses, *e.g.*, as an adjunct in theatrical displays, or as isolated spots of light giving warning of obstructions, etc. Thus in one illustrated booklet before us we observe the idea that such discs might be incorporated in the design of lamp-posts, rendering them more readily visible to drivers in the event of the lamp failing. It has also been suggested that signs composed of convex mirrors of this description would form a highly effective means of furnishing large-scale indications to aircraft, either by day or night, a suitable illuminating headlight being used in the latter case.

LOCAL INDUSTRIAL LIGHTING WITH GAS.

WHILE much attention has been given to overhead lighting of factories with powerful overhead lights, a tendency that has been encouraged by the development of higher-powered illuminants, both gas and electric, cases occur when local lighting is deemed desirable. This applies particularly to factories where close work on dark materials (dark cloth garments, boots, etc.) has to be done.

In all such cases complete shielding of the light source which is placed near to the operator is essential in order to avoid glare. It may be recalled that in the Report of H.M. Chief Inspector of Factories for 1919,* one of the inspectors referred with approval to the methods employed in certain Norwich boot factories, where the lights were attached to adjustable standards.

The accompanying illustration, for the use of which we are indebted to the courtesy of the British Commercial Gas Association, illustrates the method used in one of these installations. Bijou burners fitted with long enamelled conical shades were used and the burners can be moved and fixed in any position that the operators desire. We understand that this arrangement, which has given great satisfaction to the workers, was arrived at after considerable experiment. Features of interest are the low installation and maintenance costs, no glassware or special protectors being necessary.

Fig. 1.—Showing local gas lighting in a Norwich boot factory.

* ILLUM. ENG., Sept., 1920, p. 249.

A CONVENIENT DEVICE TO FACILITATE LOCAL INDUSTRIAL LIGHTING.

A USEFUL device, recently introduced by the Midland Trading (Nottingham) Co., Ltd., seems likely to be of service in classes of work where local lighting at constantly changing points is desirable, *e.g.*, in assembling plant and machinery, in motor repair shops, etc. The device consists of a compact reel carrying about 25 feet of strong flexible cable, at the extremity of which either a local lamp or an electrically driven tool may be used. The reel is capable of rotation about a horizontal axis in paying out the cable, which is released by a simple ratchet arrangement and kept taut by a spring. The reel as a whole can also rotate about a vertical support.

A feature is the careful insulation of all live parts with ebonite, and the complete arrangements made for earthing all exposed metal parts. It is hoped that the introduction of this device will help to eliminate the unsightly and occasionally dangerous lengths of trailing cable not infrequent in workshops, and as the cables used can carry up to 40 amperes they may prove of value in kinema studios, where the positions of the powerful lamps used are constantly being altered.

THE LIGHTING OF FOODSTUFF FACTORIES.

In planning dairies, bakeries and factories where foodstuffs are manufactured, scrupulous attention to cleanliness is necessary—a condition which is only to be realised when the lighting is adequate.

A view of the Main Factory of Messrs. Henry Thompson & Sons, at Nether Broughton.

We have received from the General Electric Co., Ltd., a description of the lighting of the factory of Messrs. Henry Thompson and Sons, at Nether Broughton, near Melton Mowbray, where pork pies, sausages, Stilton cheeses, etc., are made.

The lighting is effected by semi-indirect industrial fittings used in conjunction with 200-watt Osram gas-filled lamps, The distribution of illumination is diffused and even, and an average of 5 foot-candles is aimed at. The accompanying illustraticn gives a good idea of the conditions.

B.T.H. STAGE-LIGHTING DEVICES.

An up-to-date stage lighting equipment introduced by the British Thomson Houston Co., Ltd., and illustrated below, combines Mazda gas-filled lamps, X-ray reflectors and a frame to hold coloured gelatine slides. Four different patterns, for concentrating or distributing battens, floats and proscenium strips are supplied. The chief features are the application of gas-filled lamps and efficient reflectors for stage colour-effects, and the ease with which one coloured gelatine can be substituted for another, the arrangement being considered greatly preferable to the use of tinted lamps.

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REVIEWS OF BOOKS.

Electric Lighting in Factories and Workshops. By Leon Gaster and J. S. Dow (Sir Isaac Pitman and Sons, Ltd., London, 1921. *pp.* 37, *figs.* 19. 6*d. net*).

THIS forms the second of the "Good Lighting" series of publications issued by Sir Isaac Pitman and Sons, Ltd., and seeks to explain the essentials of good industrial lighting in simple terms. After some introductory remarks on the value of good lighting as an aid to health, safety and efficiency of work, some figures are presented showing the relation between cost of lighting and costs of production. The authors then adopt the same plan as was pursued in the first booklet on domestic lighting, of conveying information in a conversation between the lighting expert and the manager of the works. For the purpose of illustration three typical factories devoted respectively to general engineering work, clothing and boot-manufacture are discussed, and suggestions for improved lighting in each case are made. The explanations are assisted by a considerable number of views of modern lighting installations.

Industrial Medical Reconstruction in Belgium. By René Sand.

DR. RENÉ SAND, a valued Belgian corresponding member of the Illuminating Engineering Society, has written an interesting account of Industrial Medical Reconstruction in Belgium. At the outbreak of war Belgium was the most densely populated country in the world—nearly 676 inhabitants per square mile. Being also so highly developed industrially Belgium was in special need of organisations to supervise public health, and although much good work was being done by private bodies, the allocation of public funds to public health service was considered very low. Data presented for the war-period show that the death rate rose to a maximum, and the birth rate fell to a minimum in 1918; but 1919 showed a marked recovery, which has doubtless since continued. Reconstruction measures were, as in other countries, attended with difficulties, but Dr. Sand is able to show that much has been done, notably by the Labour Medical Service, which deals with the health of workers, occupational diseases, accidents, etc.

Lichttechnik. By L. Bloch. (*Issued by the German Illuminating Engineering Society. R. Oldenbourg, Munich.* 1921. *pp.* 591, *illus.* 356.)

THIS volume contains the reprinted series of papers presented before the Illuminating Engineering Society in Germany at their annual meeting in 1920, which are intended to give a survey of present progress in lighting. After a general introductory article on "The Present Position in Illuminating Engineering," by Dr. W. Wedding, there are a series of fifteen sections, each dealing with some specific aspect of illumination and compiled by experts in the respective fields. Thus, Dr. Meyer contributes a review of scientific principles underlying the production of light, Dr. Wedding deals with photometry, and Dr. A. Korf Petersen with the hygiene of illumination. Next we have sections dealing with electric and gas lighting, acetylene, oil, etc., and globes and reflectors, and lighting calculations, followed by specific problems such as the lighting of streets, schools, theatres, railways, etc. A specially interesting section is that by Dr. Gehlhoff on "Light in Connection with Optical Appliances" (searchlights, signalling lamps, etc.), and Dr. Bloch's further contribution, the last of the series, on the use of artificial light in photography, also contains much information of value. Finally, there is a comprehensive series of tables.

It will thus be seen that the volume covers a wide field, and we can only pick out a few outstanding points for mention. Most of the subject-matter, while naturally based mainly on German experience, is in general agreement with experience in this country. In the sections dealing with lamps we do not notice any novelties of outstanding interest, though a new form of enclosed long-burning flame arc is regarded as promising. In dealing with factory lighting Dr. Lux refers to the American codes, which seem to be in general accord with the recommendations of the German Illuminating Engineering Society for the lighting of buildings. The section on theatre-lighting is well illustrated, and contains some striking illustrations of the scenes and special projecting devices for producing appearances of clouds, etc. The section on searchlights is informative. It is to be noted that the latest Goerz-Beck searchlights are credited with approximately 2,000 million candlepower. This high value is doubtless due partly to the design of mirrors giving a small angle of dispersion, but mainly to the effect of the new alcohol-cooled electrode, which are stated to have a brightness of 120,000 Hefner-candles per sq. cm. (*i.e.*, approximately 650,000 candles per sq. in.!). The crater in the Lummer high pressure arc, however, is said to attain a temperature of 7,600 abs., and a brightness of 284,000 hefner-candles per sq. cm.—about twice that ascribed to the sun at zenith—but the method does not appear to have been successfully pursued in practice.

Fabrikbeleuchtung. By Dr. Ing. A. Halbertsma. (*R. Oldenbourg, Munich.* 1918. *pp.* 201, *illustrations* 122. *Mk.* 23.)

IN glancing through this work it is interesting to see how closely the views and data presented on factory lighting agree with those prevailing in this country and in the United States. The initial chapter lays stress on the influence of illumination on efficiency. The second chapter devoted to the hygiene of lighting summarises the essentials of good industrial illumination in terms practically identical with those used in the Home Office Departmental Report in this country, such points as sufficiency of illumination, avoidance of glare and elimination of troublesome shadows being emphasised. Dealing with measurements of light the author endorses the value of the lumen as the fundamental unit. A chapter is devoted to daylight and we then come to the main section of the book dealing with lamps and globes, direct and indirect lighting, special lighting appliances, etc.; shadow conditions are illustrated by effective photographs. The choice of illustrations of general industrial lighting is not so complete as in some other publications. On the other hand the account given of devices for local illumination is useful. An interesting feature in the section on planning installations is the reproduction of a circular of inquiries addressed to works prior to the preparation of a specification. Recent regulations on industrial lighting are summarised, attention being devoted chiefly to the Home Office Departmental Committee's Report in this country (1915), and the code prepared by the American Illuminating Engineering Society. The various codes now introduced by American States are apparently not mentioned, being doubtless mostly predated by the year of publication. A final chapter discusses the effect of accumulations of dust. There is an adequate index and list of references.

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EDITORIAL.

Requirements for Motor-Headlights.

It will be recalled that the requirements to be fulfilled by headlights for motor vehicles were discussed in a paper presented before the Illuminating Engineering Society by Major Garrard in March last, when the importance of confining the main driving beam below a certain horizontal plane, so as to avoid excessive glare in the eyes of approaching drivers and pedestrians, was strongly emphasised. This point receives endorsement in the third interim report, recently issued by the Departmental (M.O.T.) Committee on Lights and Vehicles, and other views expressed in this discussion are similarly confirmed.

The Committee remark that the elimination of glare in all circumstances is at present unattainable, but that many complaints of excessive dazzle are due to faulty adjustment of bulbs in electric headlights. Devices examined include (a) fittings to be added to existing lamps to confine, break up or diffuse the beam, and (b) modifications in the design of the headlight giving improved control of the beam. The first class generally involves considerable loss in the driving light, and the second class appears

the more promising. It is suggested that a driving light should consist of (1) a main beam restricted in regard to height above ground and in intensity between a certain minimum and maximum, and (2) a secondary diffused light obtained either from the head lamps or from side lamps.

The regulations proposed are two in number, namely, that the range of forward illumination shall not exceed 150 feet at any point more than 4 feet above ground, and that the front of any headlight, viewed from any point more than 4 feet above ground, shall have a reasonably soft illumination throughout its whole surface, without brilliant lines or points of light. These are supplementary to recommendations made in previous reports.

It is remarked that the enforcement of regulations on the lines suggested by the police presents practical difficulties and general compliance can best be obtained by co-operation between lamp manufacturers and owners of motor vehicles. It is also suggested that manufacturers should be able to submit devices to official organisations which, after test, should be empowered to issue certificates of approval.

In an Appendix to the Report a detailed specification defining minimum and maximum range and distribution of light in the beam, absence of dark patches, etc., is given. Range may be determined by the use of the R.A.C. disc, which is illustrated and described. This specification is regarded only as an *indication* of what is desirable and not as a basis for regulations. For various reasons the Committee do not favour the imposition of a regulation of minimum beam-illumination, as the degree of illumination needed depends much on the nature of the street-lighting provided. In London and many other cities, taxicabs, which are mainly used in relatively well-lighted streets, are equipped only with oil lamps.

The issue of this Report is of interest in view of the great amount of attention now being devoted to regulations for motor-headlights in various countries. It may be recalled that the subject was discussed at the First Technical Session of the International Illumination Commission last July, when a Report by the Committee of the American Illuminating Engineering Society was presented by Dr. C. H. Sharp.* The detailed regulations and tests described in this Report differ materially from those advocated by the M.O.T. Committee. No doubt the conditions in this country are quite distinct from those prevailing in America (where, for example, separate action is taken by individual States).

The view was expressed that an international code for motor-headlights should ultimately be attainable. Accordingly an International Technical Committee was appointed to inquire into the whole subject, and to use its influence to avoid the establishment of a number of different sets of regulations throughout the world. In each country a National Committee is to keep in touch with the International Technical Committee and report on developments, and no doubt the M.O.T. report will receive attention from the National Committee in Great Britain in due course.

* ILLUM. ENG., Oct. 1921, pp. 189–191.

The Effect of Conditions of Illumination on Efficiency of Work.

While the importance of good industrial lighting in the interests of safety, health and efficiency of work is generally recognised there has, hitherto, been relatively little evidence published showing the precise effect of better lighting in improving productive power. It is therefore interesting to note the record of some tests made by the Dover Manufacturing Company in Ohio, U.S.A., which are summarised in a recent contribution by Messrs. W. Harrison, O. F. Haas and F. W. Dopke in the *Electrical World*.

The test included measurements of the illumination prevailing with the original lighting system (0·3—12 ft.-c., with an average of 0·7), and that provided in the new lighting arrangements (13 ft.-c. average, 22 ft.-c. with the larger lamps). The extra cost of the new lighting is stated to form only 2½ per cent. of the wages bill.

Detailed tests of various operations in the factory were carried out, the time occupied by each being noted. In the great majority of operations the time was noticeably shortened, and the average estimate increase in production is given as 12½ per cent. Special instances of advantages gained by the new system of lighting are given. Thus it was formerly necessary to remove parts to a more brightly lighted spot for examination, and then bring them back for assembly; now the parts can be assembled and examined at the same spot as there is ample illumination. Again workers who cleaned up steel scrap from the presses remarked that they could now see the ragged edges of the metal and avoid injury.

Part of the advantage gained is doubtless due to better location of the lights, but the great increase in average illumination, from 0·7 to 13 foot-candles, is noteworthy as indicating an approach to the high intensities met with by daylight. In present circumstances it would appear that in general artificial lighting is frequently inferior to daylight for industrial work. It will be recalled that in the very interesting investigation in the silk-weaving industry, carried out by the Industrial Fatigue Research Board, it was found that the efficiency of production was apparently 10 per cent. less by artificial light than by daylight. But with more satisfactory methods of artificial lighting this discrepancy might well be removed.

This and other researches of the Board were described in an informative paper recently read by Mr. D. R. Wilson before the Royal Society of Arts. The study of the relation between conditions of illumination and pro ductive power falls naturally within the scope of the Board, and this question is one of obvious national importance. Considerations of national economy have, for the time being, somewhat restricted the work of the Industrial Fatigue Research Board, but we hope that in the near future it will be empowered to embark again on the many useful researches awaiting it.

Developments in Artificial Daylight.

Recent progress in artificial daylight is illustrated in several articles on the subject appearing in this issue. In connection with the Sheringham Daylight features of interest are the use of a yellow pigment in the colour-pattern, whereby greater accuracy in the imitation of daylight is stated to have been obtained, and the use of ultramarine paint of lighter tint, which substantially improves the efficiency of the device. Progress has likewise been made in the special daylight (Chance) glass; here an interesting step has been the combination of such glass with a reflector having a blue-painted interior, whereby better colour-matching properties are secured.

It is to be hoped that the attention now being given to this subject will lead to scientific tests of the various forms of artificial daylight available, and particularly to a better understanding as to the degree of accuracy necessary for various operations. This is particularly necessary in order that the public may be able to discriminate between scientifically designed apparatus giving a close approach to natural daylight, and spurious and inferior devices described as "artificial daylight" but liable to give misleading results. It is, however, probable that many people do not realise the variations met with in the quality of daylight at different times of the day and with varied atmospheric conditions. These also deserve attention. If it could be shown that the departure of artificial daylight (as regards colour-matching qualities) from normal natural daylight is less than the variations commonly met with in daylight itself in different circumstances, there would seem to be no object in striving for very much greater exactitude in ordinary commercial operations. Present methods of obtaining artificial daylight depend on subtractive methods, *i.e.*, on absorption of light, which occasion a corresponding low luminous efficiency. The greater the accuracy aimed at the greater, in general, is the loss of light. It is important, therefore, not to make undue sacrifice in this respect.

Another point to be carefully borne in mind in colour-matching processes is the effect of reflection of light from surroundings. It is surely evident that accurate observations should not be attempted in a room which receives little direct light, but is mainly dependent on light reflected from the walls of adjacent buildings, trees or other objects. Naturally such light will be appreciably coloured by reflection and one does not get normal daylight. The same, of course, applies to objects inside the room, *e.g.*, coloured wall-papers, etc. It would seem desirable to select a room which receives unrestricted light from the sky, and ensure that it contains only surfaces with as near as possible a neutral tint. To obtain consistent results tests should be habitually made in this room, not in others where the conditions may be materially different.

It is interesting to observe the variety of applications of methods of artificial daylight, and many new uses will doubtless be discovered when its possibilities become more fully known.

L. GASTER.

INDUSTRIAL LIGHTING.

Some Notes on the Annual Report of H.M. Chief Inspector of Factories for 1920.

THE Report of H.M. Chief Inspector of Factories for 1920 contains a number of references to illumination and the effect of light on the eyes. It is recalled in the introductory statement that the Departmental Committee on Lighting in Factories and Workshops issued their first Report in 1915, after which their work was in abeyance during the War. They resumed their investigations toward the end of the year (1920), but owing to the urgent need for economy it has since been found necessary to restrict their inquiries. The Committee has been assisting the Home Office in the preparation of a pamphlet on Lighting in Factories and Workshops.*

Among other pamphlets issued reference is made to the complete Report of the proceedings at the Industrial Safety First Conference organised by the Home Office and the British Industrial Safety First Association in September last year Industrial lighting received special attention at this conference, which is also referred to in the note on "Lighting in Factories and Workshops," by Miss R. E. Squire, forming one of the series of twelve chapters on specific subjects in the Report of the Chief Inspector. Miss Squire recalls the paper read by Mr. Gaster on "The Value of Good Lighting in Relation to Safety and Prevention of Accidents," and suggesting that managers and foremen in factories should make a practice of recording accidents due to faulty lighting. Allusion is made to the fact that six of the American States now possess codes on industrial lighting.

Miss Squire remarks that there is evidence that the importance of adequate and suitable lighting is increasingly recognised by employers and that employees appreciate the higher order of illumination now becoming general. The most notable defect in many installations is the presence of glare due to the indiscriminate use of gas-filled lamps without proper methods of shading. Many processes require a combination of local and general lighting. One of the best examples was afforded by a newly-equipped room of a jewellery firm. The benches for the men setting precious stones were each provided with a separate shaded electric lamp on a movable bracket while the room was well lit by gas-filled lamps, shaded with dark green shades lined with white.

One of the worst features, repeatedly commented upon by inspectors, is the neglect of natural lighting. In some cases window-space is cramped and partly blocked by stuffed rags and stored material. In a grinding hull 45 out of 70 window panes were broken, and the majority covered over with sacking! The grinders employed complained that the hull was so dark that they could not ascertain the proper finish for their work, and that considerable strain to their eyes was involved. Other cases are recorded of windows being entirely obscured with paint, or so dirty and stained with oil that natural light penetrates with difficulty.

Seeing that daylight is in general superior to artificial light and costs nothing, it is certainly surprising that it should be so neglected. The use of prismatic glass or outside reflectors for basement or overshadowed rooms is recommended, and artistic "colour-schemes" for factory walls, though adding to the general cheerfulness, should not be executed in dark colours. The tendency to use thick dulled glass for windows is deprecated, as it not only reduces daylight, but more quickly becomes dirty. It is also, by reason of the rough surface, more difficult to clean. Furthermore, such glass gives a "subdued and dreary" light which is depressing to the workers. Reference is also made to the recent methods of producing artificial daylight, which is of interest to firms engaged in colour-work.

The chapter on "Safety," by Mr J. H. J. Wilson, emphasises the spread of "safety first" ideas, and alludes to the

* See ILLUM. ENG., Oct. 1921, p. 195.

Safety Conference of last September as marking an important departure. An interesting comment is made in regard to shipbuilding, namely, that "fatal and serious accidents to young boys continue to occur and it is significant that foremen in these establishments are sometimes reluctant to employ their own sons if very young, or to agree to their employment elsewhere in ship construction, especially if such employment involves work by night." On the other hand, Mr. G. Stevenson Taylor, in dealing with dangerous trades, states that "the lighting of all parts of docks and wharves where persons are employed at night, and also the lighting on board the ships, has generally been found satisfactory." Later, while remarking that there have been many accidents in shipbuilding work during 1920, he adds, "the increased use of electric lighting has effected a considerable improvement in the standard of lighting provided on ships under construction, or repair, and also in the shipyards generally. Very few complaints have been made as to inadequacy of lighting."

Doubtless conditions in different areas are not identical, lighting in some cases being adequate, but in others insufficient.

The chapter on Industrial Diseases, by Dr. T. M. Legge, includes a report by Dr. Bridge on arc welding, which is apt to occasion eye-trouble unless proper protective measures are taken. Learners, as might be supposed, suffer more than experienced men. Inflammation usually occurs—4–8 hours after exposure and in general subsides within 24–48 hours. Additional complications (keratitis, scotomata, etc.) are reported by other observers, though Dr. Bridge himself has not met cases of permanent injury. The length of exposure necessary to cause trouble may be very short, for instance a flash lasting a few seconds, but it appears that a casual glance at a distance of 15–20 ft. does not in general produce any ill-effect, though a longer exposure, even at this distance, might do so. It is too early as yet to state whether cataract may be induced by such exposure; but it seems more likely to be produced when a short-circuit occurs and the current passes through the body of the injured person. An effective protective glass is composed of a ruby glass between two blue ones, while ordinary clear glasses, with side pieces, are some protection. Helmets equipped with goggles have the advantage of protecting workers from side-flashes, due to neighbouring work by others, and gloves and gauntlets serve to protect the skin of the arms and hands.

In an appendix by Mr. J. Herbert Parsons, F.R.C.S., F.R.S., a summary of the conclusions of the Glassworkers Cataract Committee is given. It is believed that luminous rays are not appreciably absorbed by the transparent media of the eye and cannot be responsible for cataract. The longer ultra-violet rays may pass through the corner but be absorbed by the crystalline lens. Definite changes in the lens are, in fact, produced by repeated and prolonged exposure to ultra-violet light. But it does not seem likely that glassworkers' cataract is caused in this way, except in so far as ultra-violet light may have an indirect action on the nutrition of the lens. Evidence is strongly in favour of the view that exposure to heat-energy is the active agent in inducing cataract among glassworkers. It is believed that if workers made use of the proper type of "Crookes" glasses the disease would be abolished, but it is difficult to persuade workers to adopt this protection device.

A STREET-LIGHTING SAFETY DEVICE.

In describing the new lighting installation in a park at Cleveland, U.S.A., the *Electrical World* mentions an interesting safety device. The ways that are lined by the ornamental lamp-posts are somewhat curved. In the past it has sometimes been found in such cases that in the event of a particular lamp becoming extinguished a driver may fail to see the post and run into it. Accordingly in each standard there is a coloured glass bull's-eye, about 6 ft. up, behind which is a small lamp in multiple with the main lamp on the transformer circuit. So long as the main lamp is burning the voltage of this signal lamp is so reduced that there is barely a visible glow. But if the main lamp burns out the signal lamp glows brightly and makes the presence of the standard evident.

RECENT IMPROVEMENTS IN THE SHERINGHAM DAYLIGHT.

By S. H. GROOM, B.A.

SINCE the publication of a paper by Major Adrian Klein in the issue of this Journal of January, 1921, relating to further improvements in the Sheringham Daylight, considerable progress has been made both on the technical and commercial sides, and it is the object of the present article to give a short account of these developments. A full report of the discussion at which this device was fully explained by Mr. L. C. Martin will be found in the issue of February, 1920, but it may be useful to summarise here the principles upon which the Sheringham Daylight is based.

The method employed is to allow the light from a given source to fall on a shade whose surface is covered with certain selected pigments in indefinite proportions by area, the pigments and proportions being so chosen that the excess rays of the light source (chiefly in the red and orange portions of the spectrum) are absorbed, the resulting distribution of energy approximating as closely as possible to that of average north skylight. An under-reflector prevents any direct (uncorrected) lighting and at the same time increases the amount of light falling on the shade.

If the ordinates of the energy curve of the light required are divided by the corresponding ordinates of the light from the source, a curve is obtained which may be termed the ideal reflection curve for the shade. It has been found sufficient for practical purposes for the correction to commence at $\cdot 45\mu$, *i.e.*, waves shorter than this may be neglected. If, therefore, the reflection curve is calculated on the basis of 100 per cent. at this wave-length, we have the ideal curve both from the point of view of quality and of efficiency (using the latter word in its most limited sense), while any other curve whose ordinates are smaller but in the same relative proportions is ideal as to quality but not as to efficiency. It is not surprising that no single pigment has been found which possesses the desired characteristics, but the essential point of the Sheringham method lies in the utilisation of a number of pigments in definite proportions by area such that the mean reflection curve of the whole shade corresponds as nearly as possible with the ideal.

The problem was naturally attacked by first determining the reflection curves of a large number of pigments. If we have, say, three suitable pigments, A, B and C, whose percentage reflections for wave-length λ are A_1, B_1 and C_1, the problem, stated mathematically, becomes a question of determining values of x, y and z, such that the values of $xA_1+yB_1+zC_1$ if plotted for all values of λ throughout the visible spectrum shall produce a reflection curve of the required form. An exact solution cannot, of course, be obtained by purely mathematical methods, but it is clear that if three suitable pigments are chosen, the values of the above expression may be equated to the ordinates of the required reflection curve for three values of λ (preferably at points wide apart in the spectrum). By solving the three simultaneous equations thus obtained, values of x, y and z are given which will produce a mean reflection curve coinciding with the ideal curve at the three wave-lengths chosen. If necessary, a larger number of pigments may be employed and, since there is no limit to the proportions which may be used, it will be seen that the method is a very flexible one and that small adjustments can readily be made. A very important point, too, is that a result once obtained is easily reproducible with great accuracy.

After numerous trial calculations and experiments, a shade was produced on which ultramarine, emerald-green and a small quantity of vermilion were used, which in conjunction with the gas-filled electric lamp gave a light of very satisfactory quality. Owing, however, to the comparatively low reflecting power of the pigments, it must be admitted that the efficiency left something to be desired, and it is to improvements in this direction that recent efforts have therefore been mainly directed.

An examination has been carried out of the reflection characteristics of a further large number of pigments, measurements being made by means of the Abney apparatus at the Imperial College of Science and Technology by kind permission of Professor Cheshire. As the result of these measurements, a light ultramarine has been found which is just as pure a blue as the dark ultramarine previously used, but is very much more luminous; that is to say, its reflection curve is of a similar form but very much higher throughout the whole spectrum. By a slight alteration in the proportions used, it has been found possible to substitute this pigment with the result that a greatly increased efficiency has been obtained.

An improvement in connection with the emerald-green has also been brought about by the employment of a different vehicle from that formerly in use.

A third change has been made by substituting a yellow pigment for the small quantity (about 2 per cent.) of vermilion previously used. By taking about 5 per cent. (by area) of yellow instead of the 2 per cent. of vermilion, it is considered that the energy distribution is improved. At the same time, although the area covered by the pigment is so small, its effect on the photometric value of the light is by no means negligible, since its reflection is very high for wavelengths not far removed from the point of maximum luminosity of the spectrum (about $\cdot 56\mu$). It is hoped very shortly to present the results of careful photometric tests, but in the meantime it may be stated that rough observations indicated that the quantity of light obtained has been approximately doubled by these three alterations.

Considerable attention has also been devoted to the question of the shape of the shades. In this connection it must be remembered that, owing to the employment of a matt surface, wide distribution of the light is obtained whatever the shape of the shade. If the amount of light thrown vertically downwards be regarded as the criterion of efficiency, it is clear on the approximate basis of the cosine law of reflection at a matt surface, that the shade should be as flat as possible. Such a form, however, would involve obvious disadvantages and difficulties and a conical shape has been found most convenient, at any rate for the larger units.

On the assumption of the cosine law, the efficiency of a few simple shapes as determined by the criterion suggested above, can be readily determined. Thus, in the case of a hollow cone of given base, with the source of light at the centre of the base, the light thrown vertically downwards from a small area on any part of the surface will be sin α times that reflected normally, where 2α is the angle at the apex of the cone. Since this is true for all points on the cone and the total incident light is a constant quantity, it follows that we may take sin α as a measure of the efficiency as determined by shape. It is clear that this also applies to a shade in the form of a pyramid. In the large industrial unit, α is $67\frac{1}{2}°$ and sin α is therefore $\cdot 924$ as compared with an efficiency of unity for a plane horizontal surface. Generally speaking, it may be said that the larger the unit, the more practicable does it become to use a flat type of shade and therefore the greater the efficiency.

It is found that the shape of the shade has a slight effect on the quality as well as on the quantity of light obtained. This is no doubt due to multiple reflections which take place between different portions of a deep shade. After such reflections, the residual light tends to approximate more closely to the colour of the reflecting surface; in other words an over-correction is caused. This effect, however, is not very large in normal cases, as two or more reflections involve considerable absorption and the residual light is therefore of weak intensity. Another cause which slightly affects the quality of the light is the position of the lamp. If the bulb be placed in the usual position, with the point downwards, a considerable amount of light is reflected from the top of the interior of the lamp or from the mica disc employed in some of the gas-filled bulbs. If this light emerges mixed with the reflected light from the shade it naturally affects the quality of the total light. In practice it is found that these sources of variation can

EXAMPLES OF PRACTICAL APPLICATIONS OF ARTIFICIAL DAYLIGHT.

Fig. 1.—Showing the use of Daylight Unit (No. 850) to facilitate grading of wheat (Messrs. Vernon & Co., Ltd., Cunard Buildings, Liverpool).

Fig. 2.—Use of Artificial Daylight Unit (No. 850) over artist's desk (Sun Engraving Co., Watford).

Fig. 3.—Two - light Standard (No. 610) for use on shop-counters. The small fitting contains an ordinary lamp that can be switched on for purposes of comparison.

Fig. 4.—Matching artificial teeth by aid of model No. 615 (Messrs. De Trey & Co., Ltd., London).

be corrected by slight alterations in the amount of yellow pigment used; thus a smaller quantity is required when any uncorrected light is present.

One fundamental difficulty in any attempt to produce artificial daylight is in deciding on the exact character of the light which it is desirable to simulate. This question received considerable attention in the discussion referred to above and need, therefore, receive only passing mention here. As is well known, natural daylight itself is continually changing, both in intensity and spectral character. The spectrophotometry of such light is, therefore, an exceedingly difficult and tedious matter, as these changes occur during the carrying out of a single set of observations. It certainly appears desirable, however, that an attempt should be made to standardise one or more types of daylight. It is equally desirable that measures should be taken to enable the general public to discriminate between genuine attempts by whatever method, to produce a reasonable approximation to daylight, and crude productions which may be placed upon the market. The worst "daylight" the writer has seen would actually deceive none but the colour-blind, but there is the danger of such productions when labelled as "daylight" lamps bringing the whole subject of artificial daylight into disrepute.

In the case of the Sheringham Daylight, an attempt has been made to obtain an energy curve somewhere between those published for blue sky- and sunlight. In view of the absence of a definite standard and the difficulties of accurate spectrophotometry in the case of a diffused light, there appears to be no better test of satisfactoriness than the comparison of the appearance of a large number of pigments under the artificial light and under the light from the north sky on a dull day. A mere observation of the two hands under the different circumstances is a rough-and-ready test of considerable value, as flesh tints appear to be peculiarly sensitive to changes in the spectral character of the illuminant.

The types of Sheringham Daylight units at present on the market include two industrial shades of 30 in. and 18 in. diameter respectively, the larger being intended for use with 1,000-watt or 500-watt lamps and the smaller with 300-watt lamps. A special feature of these units is a ball-jointed focussing top which allows perfect adjustment to be made both vertically and laterally, thus enabling every lamp to be utilised to the best advantage. In view of the amount of variation in different bulbs and in the position of the filament with respect to the bulb, this is considered to be a most useful refinement in a unit in which accurate direction of the light is desired.

Two types of standard lamp are also being made, each employing a 150-watt bulb. One of these is a two-light fitting, an ordinary light being immediately available for purposes of comparison by the manipulation of a two-way tumbler switch. The other standard is a reading lamp of high-class appearance suitable for use in the library or drawing-room.

Special units in which the angle of inclination of the shade can be adjusted are also being made for pictorial illumination in art-galleries, while there are two types of trough shade for studio lighting or shop windows, one taking three 300-watt lamps and the other three 150-watt lamps.

Finally, two small hanging units for 150-watt lamps are available, one of which is provided with a counterweight and universal tilting adjustment, rendering it especially serviceable for the medical and dental professions.

An interesting feature of the commercial development of artificial daylight units has been the ever-increasing sphere of usefulness which has been found for the lamps. In addition to the more obvious uses in dye manufacture, textile printing, art schools, public galleries, etc., it has been found that an immense number of other industries depend for their efficiency on an accurate rendering of colour-values. As examples, it may be mentioned that workers engaged in the grading of flour, rubber, tobacco and fur, as well as stamp-dealers, have found the light of considerable value.

GLASS FOR ARTIFICIAL DAYLIGHT.

By F. E. Lamplough.

Glass to correct the gas filled lamp to the equivalent of daylight was developed by Messrs. Chance Brothers & Co., of Birmingham, early this year. This glass was first brought to the notice of the public in February, when it was shown at the *Daily Mail* "Efficiency" Exhibition at Olympia. The glass was subsequently improved and placed on the market in April. Electrical fittings with this glass are now obtainable.

This glass is remarkable for the smoothness of the curve representing the spectral intensities of the transmitted beam of corrected light. Long and costly scientific effort has been necessary to obtain this result.

A very convenient feature of a daylight glass is the fact that such a glass which gives a good correction to average daylight in a particular thickness will give equally good correction to blue sky effect when used in a greater thickness, and noon sunlight when thinner glass is employed. This control over the type of correction required also gives a ready means of allowing for variation in the yellowness of electric lamps according to their power. Thus a 500 watt lamp requires a thickness of glass about 10 per cent. less than that which suits a 100 watt lamp, and gives correspondingly greater efficiency. Hence an efficiency of 40 per cent. is secured with a thickness of glass giving the correction to average daylight preferred by dyers.

In the exhibition of new apparatus at the meeting of the Illuminating Engineering Society on November 15th a triple compartment cabinet was shown to demonstrate the accuracy of the correction and the glaring inaccuracy in the correction obtained when another blue glass is used, which nevertheless gives a good general correction of the yellowness of artificial light to the whiteness of daylight. One compartment was lit by a lamp fitted with the daylight glass, another fitted with the glass which gave the apparently similar but spurious correction; and a third, for comparison, with uncorrected light. In the case of many sensitive dyes the colours were very little corrected by the inferior glass.

Among the first to be very interested in this glass were some well-known dyers, who have given a high opinion of daylight units fitted with it, and are thus enabled to continue their work confidently at night.

The striking variations in daylight which are always taking place are very noticeable when working with sensitive colours, and a lamp fitted with daylight glass gives a better average daylight than is usually obtainable in the neighbourhood of large towns. We have had striking proof of this in the experience of a restorer of old and valuable paintings. This worker has been so delighted with the effect of working with a daylight lantern that he prefers now to work by its light, even during the day, to avoid the vagaries of English skies.

Though the nature of the absorption of Chance's Daylight Glass ensures excellent matching between different colours, the general tint of the corrected beam has purposely been left very slightly greenish in order to secure high efficiency.

The departure from normal daylight involved is less than that occasioned by various extraneous circumstances that are met with in using natural light; for example, the effect of somewhat dirty windows or the presence of coloured walls or other objects inside or outside the room, all of which affect the colour of the "daylight" received.

Though simple lanterns with the glass have been found entirely satisfactory in the severe matching tests to which a daylight unit is subjected by dyers, those who prefer to do so may achieve a more perfect equality to the tint of average daylight if the lantern is fitted with an inside reflector of a special "spectrum blue" heat resisting paint which we have developed. The correction of the light is thus shared by the reflection of light from the paint, and a somewhat thinner bowl of "daylight" glass may be used. Consequently there is a loss of only a further 4 per cent. of the incident light. This effect could be secured also by a modification of the glass, but no greater general efficiency would result.

THE MEASUREMENT OF COEFFICIENTS OF REFLECTION.

The paper by Mr. A. H. Taylor on this subject,* which has already been dealt with in this Journal, has now been supplemented by a contribution by Dr. C. H. Sharp and Mr. W. F. Little, presented at the 14th Annual Convention of the Illuminating Engineering Society in the United States.

The method of ascertaining coefficients of reflection explained in this paper, like those formerly described, is based on the use of an integrating sphere, but has the advantage of simplicity, and is also stated to enable the coefficient of reflection to be easily obtained for semi-polished materials.

The theory of the method is as follows. If light is projected through a small aperture into the sphere so as to form a small bright spot on its diffusely reflecting walls, this spot will give to all the rest of the sphere-surface a uniform brightness. If an opaque white screen is interposed between the spot of light and the small area of the sphere at which the brightness-photometer is directed, this screened test-spot will receive an illumination from the rest of the sphere which is equal to the brightness of the remaining sphere-surface (*i.e.*, the flux incident per unit area on the screened test-spot will equal the flux reflected per unit area by the portions of the sphere outside the test-spot and the illuminated spot). Hence, if the photometer observes first the brightness of the test-spot when shaded by the screen, and second, the brightness of the sphere-wall outside the screened area, the ratio of these two brightnesses will be the reflection factor of the test-spot. Thus, if B is the brightness of the sphere, E_s the illumination of the small screened area, B_s the brightness of this area, and R the reflection factor of the test-spot, we have :—

$$B = E_s, \text{ and } R = B_s/E_s = B_s/B.$$

* Illum. Eng., Oct.-Nov. 1920.

The portion of the sphere forming the test-spot may be removable, so that any sample surface can be substituted, and the photometer can be rotated slightly so as to look alternately at the test-spot and at a nearby portion of the sphere-wall outside the screened area.

If the test-sample is a regularly reflecting mirror the photometer will see on the mirror an unscreened portion of the sphere-surface. The true brightness of this being B, the observed brightness, B_s, will be rB, where r is the reflection factor of the mirror, and again $r = B_s/B$. Thus, the comparison of the brightness of a test-sample with the brightness of the sphere-surface gives the reflection factor alike when the test-sample has a diffusing surface or a regularly reflecting one. Hence, such an observation will also give the reflection factor of a surface which is intermediate in nature, *i.e.*, semi-polished.

As the reflection factor of a plane mirror can be ascertained with great exactitude on a photometric bench, such a mirror affords an easy means of checking results obtained with the sphere. The various factors influencing the accuracy of the method, *i.e.*, the possibility of a material departure from true diffusivity of the sphere-surface, the influence of the screen and the area covered by the spot of light (both of which should be small) have still to be studied. But the principle of the method appears correct, and results so far obtained suggest that the errors involved are relatively small. In the original paper the author gives a brief description of the apparatus, which involves the use of a 12-in. sphere, into which light is projected from an automobile headlight with condenser and objective lenses. The photometer used had a Lummer-Brodhun cube with a very small central aperture.

A number of surfaces were tested by this method. A reference sample for which Mr. Taylor found a reflection factor of 0·84, yielded the value 0·83. Similarly results agree with experiments at the Bureau of Standards in assigning a value of 0·98 for the reflection factor of magnesium carbonate blocks.

THE FIRST GAS-LIGHTED CHURCH.

In a recent issue of the *Co-partnership Journal*, to whom we are indebted for the illustrations accompanying this note, it is mentioned that at the time when Queen Victoria came to the throne there were many City churches in which the lighting arrangements were limited to candles on the pulpit and the reading-desk, although a supply of gas was already available in Westminster and London.

through a circular aperture and was burnt in a manner that would of course now be regarded as extremely insufficient.

The Church of St. John, Westminster, was built between 1714-1728, and has many interesting features. The original works of the Chartered Gas Company were erected quite a short distance away. It appears that the lighting of this church was subsequently converted to electricity,

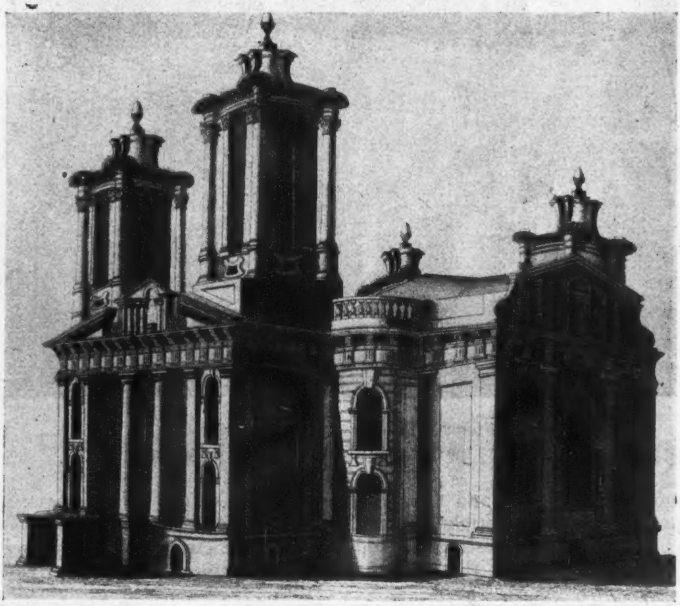


FIG. 1.—The first church to be lighted by gas: St. John the Evangelist, Westminster. [*From an old print.*

It appears that the first church to be lighted by gas was the Parish Church of St. John the Evangelist, Smith Square, Westminster, a view of which appears in Fig. 1. Accum, writing in 1816, said that the building had been illuminated by gas lighting for upwards of two years—the light employed being "equal to 360 tallow candles, eight to the pound." Nothing is said of the design of the fittings and types of burners used in this church. Apparently the gas merely passed

but it is remarked that there is nothing to indicate that modern gas lighting was given a trial, seeing that electric lamps are now fitted to ancient brackets which were evidently constructed for flat-flame burners.

In contrast to this, the *Co-partnership Journal*, in a subsequent issue, mentions an interesting case of another church, also of considerable historic interest, which has been lighted by gas for many years. This is the Parish Church of

St. Mary, Walton-on-Thames. From the nave roof there still hang two beautiful chandeliers of polished brass, each with twelve arms. These were originally used for candles, but were fitted many years ago with gas pipes and flat-flame burners. Afterwards upright incandescent burners were substituted, and finally, some years before the war, the arms were turned over and fitted with inverted mantles. The aisles and galleries are lighted by "C" burners, and the chancel by a seven-light chandelier with inverted burners and two three-light standards with "C" burners. Fig. 2 gives a good idea of the brass chandelier used in the church as it appeared before the use of incandescent gas-lighting.

FIG. 2.—Interior of Walton Church.
(Before the advent of Incandescent Gas-lighting.)

A NEW GAS-IGNITER.

In the past many devices to secure automatic kindling of gas, based on the use of platinum sponge or of sparks produced by friction of cerite contacts, have been devised.

The "Perpetuum" gas-igniter, described in *Gas und Wasserfach*, represents an attempt to use a discharge of static electricity to kindle a stream of gas. The apparatus, which is housed in a metal case terminating in a cylinder, contains an electrophorus apparatus which is manipulated by a knob outside the case. The two contacts, across which the spark passes, are situated at the end of the cylinder. This is pierced by a series of holes from which sparks emerge. It is stated that in recent tests upwards of 100,000 successive ignitions have been made without any appreciable deterioration in efficiency taking place.

PERSONAL.

Mr. Walter T. Dunn, M.I.Mech.E., Secretary of the Institution of Gas Engineers, has been elected a Member of the Council of the Chartered Institute of Secretaries.

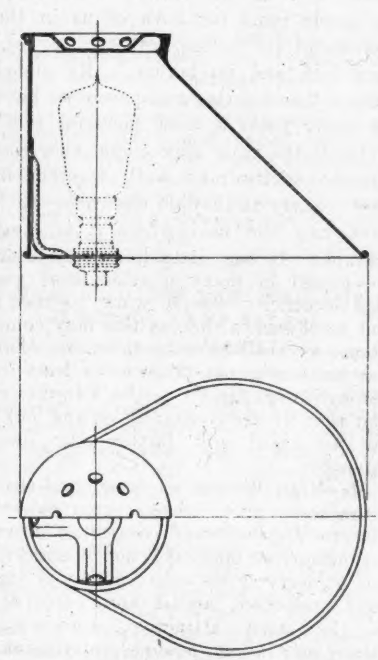
LOCAL GAS-LIGHTING FOR RAILWAY SIGNALS.

AN interesting example of concealed gas lighting is to be seen on several stations on the London and South Western Railway, of which the accompanying illustration gives a good idea. We understand from Mr. Cunnington, Lighting Engineer to the L. & S.W. Ry., who kindly made arrangements for this photograph to be taken, that these particular signals are of the "indicating" or "repeating" type, *i.e.*, they are supplementary to the ordinary semaphore signals, being worked in conjunction with them. On several portions of the line there is a length of slightly curving track before entering a station, and without

this supplementary signal the engine driver might have to slow up before the main signal came into view. The illustration shows the arrangement at Wandsworth Town station, where the supplementary signal shown is situated at the extreme end of the platform roofing, and is easily visible a long way off. The signal consists of a red-painted arm moving on a white background and illuminated by a two-burner gas lamp slightly above and in front of the white plate. The illumination on the signal is approximately $4\frac{1}{2}$ foot-candles. An important feature is the fact of the mantles being completely screened from the eye of the driver so that there is nothing to interfere with his view of the illuminated signal.

AN "ANTI-GLARE" FORM OF REFLECTOR FOR OFFICE AND TABLE USE.

THE accompanying illustrations show a form of reflector recently devised by Surgeon-Commander R. J. E. Hanson, O.B.E., R.N.V.R., which presents several interesting features, and is intended for use in lighting tables, offices, churches, etc. The somewhat unusual form of the metal reflector is adopted specially with a view to uniform illumination of desks, tables, etc., for which the unit is conveniently used. The lamp-filament is completely screened from view.



Another point of interest is the coating of the interior of the reflector by Duresco paint, whereby a matt surface, which eliminates inconvenient polished reflection, but can nevertheless be readily cleaned, is obtained. It is proposed to give this surface a yellowish colour, such that the light emerging from the reflector assumes a pale lemon tint—a condition which is considered to be beneficial to vision.

GAS COMPANIES AND THE CONSUMER.

IN his recent address before the British Commercial Gas Association, Mr. D. Milne Watson referred to the future possible co-operation of gas and electricity undertakings, but urged that meanwhile, until this era arrives, gas companies should continue to utilise the most effective means of publicity, *i.e.*, giving good service to the consumer. He added :—

"This Association, though essentially pro-gas, is not an anti-electricity organisation. . . . We believe that there is ample room for both of us in the service of the nation. All we ask is a fair field and no favour." He added later : "In lighting and power we have in many fields a most powerful rival. I think the time may come when gas and electricity may work together in this country as they do elsewhere—each occupying the field where it is most suitable. It has, indeed, already been recognised in many quarters that gas and electricity should work together ; but until such a time as this may come about we shall have to take care that our business is not taken away from us through our negligence and backwardness, and that we are constantly on the look-out to guard and further our own interests."

Mr. Milne Watson wisely advised that "the best way to increase your output and to prevent your competitor from capturing your business is not by abusing him or decrying his wares, but by giving your customers, actual and potential, in the most attractive, convincing form, the fullest possible information about what you can do for them, and then (having secured their custom) serving them even better than you have led them to expect." For this purpose a specially trained staff is essential. Training can be conveyed largely through suitable handbooks, and Mr. Goodenough, at a later stage of the conference, mentioned the forthcoming publication of a book of *Notes for Teachers*, in which, no doubt, the principles of good lighting by gas will be explained and illustrated.

DEMONSTRATIONS OF ADEQUATE INDUSTRIAL LIGHTING.

IN the United States a special feature has recently been made of demonstrations of industrial lighting, and the National Electric Light Association has made itself responsible for a programme of such displays in all the larger cities. According to an account in the *Electrical World* the demonstrations so far conducted have met with remarkable success. Experience has shown that the printed word or even a verbal explanation is inadequate to carry the message of what good lighting is and can do. Managers who have formerly believed that the lighting in their works was entirely satisfactory have come to change their views when they have an opportunity of seeing the very latest methods in operation. To the majority of people the conception of illumination as the final product at the working plane is still unfamiliar : there are even many who are technically concerned with lighting who still think exclusively in terms of outlets, lamps, switches, sockets, etc.

In order to deal effectively with the problem the National Electric Light Association is establishing a lighting department, controlled by a committee, to prepare permanent demonstration outfits for the various centres. Naturally the plan adopted must vary with the space available, and it is not practicable to design a demonstration room of universal application.

The essence of the movement is to be found in the assumption that "the central station, whose business it is to sell light, is naturally responsible for the lighting education of the community." A case is quoted of one area where the central station takes the lead in this matter. The manager, after witnessing a "modern lighting" demonstration, became convinced the possibilities of development in his district were much greater than was previously conceived. He arranged for a demonstration in his city, which was attended by managers from all the works around.

TOPICAL AND INDUSTRIAL SECTION.

[At the request of many of our readers we have extended the space devoted to this Section, and are open to receive for publication particulars of interesting installations, new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona-fide* information relating thereto.]

A VISIT TO THE SHOWROOMS OF MESSRS. WM. SUGG & CO.

In a recent visit to the showrooms of Messrs. W. Sugg & Co., Ltd., we had an opportunity of examining recent developments in gas-fittings, some of which are a great improvement on those in common use only a few years ago. One of the chief features of modern methods appears to be the use of "cluster-lights," which are now being widely used both for indoor and outdoor lighting. Another advance is the introduction of conversion fittings, whereby fittings with upright burners are easily changed to superheated clusters of two or more inverted mantles, the general appearance of the lighting unit being still retained.

The conversion is specially happy in those cases where vitreosil or other diffusing globes or chimneys are used, so that the actual mantles are not seen. As special instances we may mention the pedestal light utilising inverted mantles within a diffusing bowl, which has quite the effect of a corresponding electric unit; and the small bracket lights, likewise utilising an inverted mantle within a vitreosil chimney, but preserving the appearance of an upright fitting. The impression of the diffusing globe is enhanced by the polished grey metal work, forming a background to these bracket-lights. In the new "Surbiton" fitting we have again a pleasing combination in a polished aluminium case terminating in a milk-white silica globe. The advantage of the diffused light rendered by such a fitting doubtless outweighs any loss in light occasioned by the use of the globe. Other interesting fittings are those of the semi-indirect type, and the corridor ceiling lights which can be mounted almost direct on the ceiling as is customary with electric units.

One highly ingenious list relating to school-lighting shows, side by side, a number of obsolete fittings such as are often used in classrooms, with the corresponding improved type suggested as a substitute. It is stated that conversions of this kind have been made with good effect by the London County Council schools, the cost of the conversion being covered within a short period by the saving effected in gas.

A NEW SOLUTION FOR COLOURING ELECTRIC LAMP-BULBS.

The colouring of lamp-bulbs by special solutions has long been a troublesome process, the difficulty being to find materials and colours which will withstand the heat of the filament, be impervious to moisture, and also stand washing. A series of solutions, for which John Richardson & Co., of 98-101, High Stratford, are agents, is claimed to overcome these difficulties. We recently witnessed a demonstration of the application of this solution, which is made in twenty different colours. After thoroughly cleaning the lamp-bulb it is merely immersed (cold) in the solution, removed without shaking, and hung up to dry. This gives a uniform and adhesive colouring, the surface of which can apparently be heated with a spirit-flame without undergoing visible deterioration. It is also stated that the lamps can be immersed in hot or cold water and scrubbed to remove dirt without the colour suffering. One special solution has been prepared which gives a "frosted" appearance to the lamp. It is claimed that the surface thus produced, being smooth, does not readily collect dust.

We were informed that lamps treated by these special solutions have burned

their full life without any appreciable deterioration of the colouring film, and that, apart from the preservation of a smooth and continuous surface without cracks, the colours are all quite fast—the only exception being violet, which at present is apt to become decolorised in course of time.

The process should be of considerable interest to makers of luminous signs, theatre experts and others concerned with the use of lamps with coloured bulbs, and if further experience confirms the permanence claimed for such solutions they may find other applications.

WELSBACH FITTINGS.

In a recent visit to the showrooms of the Welsbach Light Co., Ltd., we had an opportunity of examining specimens of the various types of mantles made by the firm, and gathered that although inverted mantles are now naturally installed in most new installations, there is still a considerable demand for those of the upright type. A feature is the soft mantle, largely used for incandescent oil lamps, one particularly large mantle being made for the powerful lights used in lighthouses. It was interesting to note that this firm, in common with others, is dealing with cluster and conversion units, and fittings using the new vitreosil glassware.

MOTOR LIGHTING EQUIPMENT.

The Allen-Liversedge catalogue dealing with motor-lighting equipment contains a particularly full account on applications of acetylene of interest to motorists. Special reference is made to the advantages of dissolved acetylene, now available in standard cylinders containing 40 cub. ft. of gas. Smaller cylinders using 6 or 12 cub. ft. are also listed, and these are specially recommended for emergency lighting. Head lamps commonly utilise a flame-burner consuming about ½ cub. ft. of gas per hour, but we also notice others equipped with the oxy-acetylene incandescent pastille, as used in searchlights.

Other features include motor-bus lamps, tail lamps, etc. Finally we note an account of the Rolph automatic traffic warner, by the aid of which a driver can conveniently signal to a car behind him, in the event of his desiring to slacken down, etc.

SEMI-INDIRECT FITTINGS.

We have received from the Sun Electrical Co., Ltd., some particulars of a new type of Alabaster Indirect Fittings, of which the illustration shows a typical example. These fittings are made of the indirect bowl type and, as the illustration shows, they are also being made with an upper reflector to correspond with the bowl.

Semi-indirect lighting is now being widely used in large interiors. In cases where it is desired to avoid big centre units for distributing the light, these fittings, which are suitable for use with 60 or 100 watt gas-filled lamps, are particularly recommended.

LUMINOR SIGNS.

With reference to the note on the above subject that appeared in our last issue (page 204), we understand that the method of mounting separate mirrors with a screw or bayonet holder is with the idea of replacing lamps in existing electric signs during the summer when such signs are commonly not illuminated. The attachments are not suitable for replacing mirrors in Luminor signs that show signs of wear. It is claimed, however, that signs should not be affected by weather and that any faulty discs are replaced free of charge.

INDEX, November, 1921.

CORRESPONDENCE.

INCANDESCENT GAS MANTLES AND UNEMPLOYMENT.

October 25th, 1921.

SIR,—The members of this Association have allocated a substantial sum of money for the purpose of issuing announcements in a number of daily papers, to call the attention of the public to the grave bearing on unemployment in this country of the importation of large quantities of foreign mantles.

Within quite recent times some millions of such mantles have been imported here. They are mostly put up in plain boxes, without the country of origin stated thereon, and not infrequently are labelled on this side with the names of British firms—thus misleading the public as to the country of manufacture. The low value of foreign currency (especially in Germany, from which most of the foreign mantles emanate) enables the manufacturers to obtain a price which, although substantially higher than is obtained in their home markets, is below the cost of manufacture here. Thus buyers here help to find money to pay the reparations, to the detriment of home industries. As the result of such imports, mantle manufacturers in this country are working with reduced staffs, and even then only at part-time, instead of its being possible, as should be the case at this season of the year, to find whole-time employment for the maximum number of workpeople.

May we through your columns enlist the co-operation of dealers and distributors and public bodies throughout the country to back up our efforts in stimulating the demand for British-made mantles, and thus enable the large numbers of British workers engaged in this industry to be provided with full-time work at Trade Union wages, and, incidentally, save the taxpayers' money, which would otherwise be paid away in the demoralising unemployment dole ?

C. J. HEALY, Secretary,
Incandescent Mantle Manufacturers' Association.

11-12, Pall Mall, S.W.

ENGLISH ELECTRIC AND SIEMENS SUPPLIES, LIMITED.

We are asked to mention that on and after November 1st the Registered Offices of Messrs. The English Electric and Siemens Supplies, Ltd., will be transferred to the firm's City premises at 38 and 39, Upper Thames Street, London, E.C.4, where all future communications should be sent.

THE FOOT-CANDLE METER.

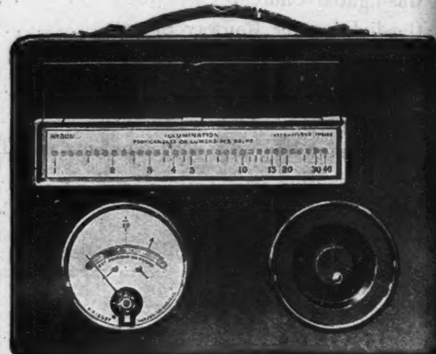
THE small "foot-candle meter" now being supplied by the British Thomson-Houston Co., Ltd., has some interesting features. The general view of the instrument (Fig. A) shows the graduated scale at the top, the volt meter (bottom left), the rheostat switch (bottom right). The locking pin in the switch handle prevents the lamp from being accidentally switched on and also prevents the instrument from being put in the leather case when the switch is on. The total weight with case is 4 lbs. and the outside dimensions of the instrument are 7¾ in. by 6 in. by 1½ in.

The screen (Fig. B) forms one side of the light box and consists of a piece of clear glass on which are two thicknesses of paper. One sheet is fairly opaque and is pierced with round holes, and the other is translucent. The electric lamp, fitted with a small reflector, is at the right-hand end of the light box. The holes to the right will appear brighter than the screen, and those to the left darker. At a certain point on the screen the internal illumination is equal to the external illumination, and here the illumination in foot-candles is registered

Figure C shows the back of the case opened, with a section of the light box cut away to show the lamp and a part of the reverse side of the screen. The dry battery supplying current to the lamp runs the whole length of the case above the light box. Any battery of the same size and type may be used as a replacement. By turning the switch handle until the volt meter pointer is over the arrow mark on the dial, the series resistance is so adjusted as to ensure correct voltage at the lamp.

The use of the instrument is very simple. The meter is placed on the table, bench, counter or wherever the illumination measurement is to be taken. After raising the hinged cover of the screen, the locking pin in the switch handle is lifted, and the handle turned to the right until the pointer of the dial on the left comes to rest at the arrow. A look at the screen will then enable the user to determine easily which of the round spots matches the background. The figure at the selected round spot gives the foot-candles.

Further particulars of the instrument may be obtained from the Illuminating Engineer's Department of the British Thomson-Houston Company, Ltd., 77, Upper Thames Street, London, E.C.4.



A.—General view of instrument.

B.—Showing Screen.

C.—Showing back of case opened and details of instrument.

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The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by LEON GASTER

THE JOURNAL OF SCIENTIFIC ILLUMINATION.

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EDITORIAL.

Recent Developments in Illuminating Engineering.

The opening meeting of the session of the Illuminating Engineering Society on November 15th was devoted, as is customary, to reports of progress and exhibits of interesting novelties in lighting appliances. Among the events recently recorded special importance attaches to the First Technical Session of the International Illumination Commission, which marks the resumption of international procedure in matters of illumination. Attention was also drawn to various official reports illustrating the interest being taken by Government Departments in various aspects of lighting, notably the Second Interim Report of the Departmental (Home Office) Committee on Lighting in Factories and Workshops, the Interim Report of the M.O.T. Departmental Committee dealing with Motor Vehicle Headlights, and the Report of the Committee working under the Ministry of Health on the effect on vision of lights used in Kinema Studios. All these three subjects have received special attention from the Society, and it may be noted that several of the exhibits were of interest in this connection such as the new types of headlights shown by Mr. Armstrong and

Mr. Jones, and the types of reflectors for industrial lighting described by Mr. G. Campbell.

In the field of gas lighting, recent progress has been ably summarised in the paper by Mr. Sandeman presented before the Society on December 13th, which will be dealt with in our next issue. The Committee concerned with Electric Lamps and Lighting Appliances indicated that progress during the last year in this field has involved development in detail rather than any radical departures. It is satisfactory to note that, according to the Report, adequate stocks of reflectors for use with the smaller gasfilled lamps are now available, and that attention is being given to the standardisation of dimensions of lamps and positions of filaments within the bulb, so as to be suitable for use with the available reflectors in existing properly arranged lighting installations. Changes in the design of lamps, made without due consideration of this point, may give rise to glare. No doubt lamp manufacturers will confer with makers of reflectors before radical departures in the shape of lamp-bulbs, etc., are decided upon, with a view to avoiding inconvenience of this kind.

The exhibits at the meeting proved to be of great interest. Progress in illumination-photometers was illustrated by a simple form of instrument shown by Mr. Haydn T. Harrison, which seems to have convenient qualities for the demonstration of values of illumination. The exhibits by Mr. S. H. Groom and Mr. F. E. Lamplough indicated that steady progress is being made in the design of artificial daylight appliances. The latter's explanation of the misleading results liable to be obtained from spurious forms of "artificial daylight," in which the distribution of light in the spectrum necessary for accurate colour-matching is not reproduced, was of special value. We have previously pointed out the need for scientific tests of artificial daylight units, with a view to determining the order of accuracy necessary for various classes of work, and the precision with which such artificial daylight is reproducible, and the distinguishing between approximate and exact devices. The new "discharge" lamps utilising luminescent neon, shown by Mr. H. A. Carter, seem to have possibilities for use in luminous signs, etc., and constitute a striking departure in method which may be further developed. Other demonstrations by Mr. E. T. Ruthven Murray and Major Amcotts related to luminous and convex mirror signs, and aptly illustrated the continuous progress that is being made in this field.

Much interest was aroused by the exhibit, by Mr. W. J. Jones, of the use of ultra-violet light as a means of distinguishing Oriental from Japanese cultured pearls, and genuine gems from artificial ones, etc. Many other materials (including various oils and fats) will fluoresce under the action of these rays. It is possible, therefore, that we have here a new and valuable supplementary method of analysis in discriminating between genuine and imitation products. This is obviously a subject that requires further study as the method would presumably only yield accurate information in the hands of experts who have learned to interpret, amongst other factors, the variations in brightness and colour of the fluorescence produced.

The Effect of Variations in Illumination on Visual Efficiency.

Whereas, only a few years ago, little information was available as to the illumination necessary for various operations, tables of values of foot-candles for various classes of service are now common. Standards for rough, medium and fine work have also been embodied in the legislative codes of industrial lighting of various American States. Probably such values are best regarded as denoting the best modern practice, rather than the ideal. In many cases further experimental tests of the improvement in speed and precision resulting from higher orders of illumination are needed. The amount of illumination provided is not the *only* factor influencing ease of work. Such matters as the exposure of the eye to glare, the contrast between the brightness of the illuminated material worked upon and the surroundings, the effects of shadow, and the colour of light yielded by the illuminant may prove of equal moment. Again, whereas some intricate processes may become, by long practice, so simple that an experienced worker can manage quite well with relatively low illumination, provided such distracting factors as glare and inconvenient shadows are absent, a much higher value is needed by an operator to whom the process is unfamiliar.

The problem is thus a complex one which requires a great deal more study. Interesting information is afforded in some tests recentlyconducted by Messrs. M. Luckiesh, A. H. Taylor and R. H. Sinden* on the relation between intensity of illumination and the efficiency of visual operations. As an indication of visual efficiency the authors determined the speed with which a line of type could be read. The results are assembled in a diagram relating speed of reading with intensity of illumination (A) using material (reflection factor 22·5 per cent.) giving a low contrast between type and background, (B) with material (reflection factor 80 per cent.) giving relatively high contrast. The latter curve thus corresponds most closely with ordinary reading. Inspection of the curves shows a rapid advance in speed of reading with illuminations up to about 4 foot-candles, a less rapid but still appreciable improvement from 4 to 12 foot-candles, and a relatively gradual change from thence on to the highest illumination used, viz., 28 foot-candles. When the contrast between type and background is diminished, as illustrated by case (A), the effect of increased illumination is still more pronounced, the gain in speed with increasing illumination being still very evident at illuminations over 20 foot-candles, with little indication of finality.

It would appear from these tests, that in this case an advantage was secured by increasing the illumination considerably beyond the values at present customary in schools and offices, etc. The authors, however, used words in Old English type. With ordinary familiar reading type the effect of increasing illumination might have been much less. Some indication is also afforded of the effect of colour of light, a somewhat higher illumination being needed with a mercury vapour lamp than when tungsten lamps are used, whereas for the observation of very fine detail involving high visual acuity the converse result has been recorded. This is another indication that the exact nature of the test-process requires very careful consideration. We hope that experiments of a similar kind on other processes will be conducted.

* *Elec. World*, Oct. 1st, 1921.

Public Lighting.

The paper on the above subject presented by Dr. Thomas and Mr. Chandler at the Public Works, Roads and Transport Congress on November 18th contained gratifying evidence of the close attention that is being devoted to street-lighting in the South Metropolitan Gas Company's district. In particular we appreciated Dr. Thomas's remarks on the importance of scientific method in public lighting, and the tribute paid by him to the work of the Illuminating Engineering Society. An excellent opportunity was afforded of bringing the question of street-lighting before surveyors, a number of whom joined in the discussion. The writer can recall reading a paper in the same hall on " Efficient Illumination and Municipal Requirements " at the Municipal, Building and Public Health Exhibition of 1908, *i.e.*, in the year preceding the formation of the Illuminating Engineering Society. It was evident even then that public lighting would demand close attention during subsequent years. One factor that has doubtless been largely responsible for the modern recognition of the importance of adequate street-lighting is the development of fast motor-traffic, which has entirely altered the standards of the past.

Dr. Thomas referred to the variety of terms used in illuminating engineering. The varied methods of definition and nomenclature used in different coutries has certainly been a difficulty in the past. It is therefore gratifying to be able to record that substantial progress towards agreement has been reached through the work of the International Illumination Commission. Agreement has already been reached on definitions of the three fundamental quantities, candlepower, illumination and flux of light, and their units. The phrase adopted by the authors comparing lamps in terms of " mean candlepower per 1/100 therm per hour " is somewhat lengthy. Possibly one might adopt for this unit the " Murdoch " instead of applying this as Dr. Thomas suggested to the foot-candle, already a familiar term.

General agreement was expressed in regard to the importance of avoiding glare and undue contrasts in brightness in street-lighting—for example, in grading the illumination as one passes from a side street to a more brightly illuminated main street, or *vice versa*. Similarly, although different methods of lighting may be used on a main thoroughfare as it passes through different municipal areas, it should be possible to preserve approximately the same order of illumination.

Uniformity of practice in this respect would be greatly aided by some suitably constituted central authority, which would classify streets according to the importance of traffic, and prescribe appropriate values of illumination. Information acquired in London would no doubt prove useful in other cities, so that in course of time the same general principles would be applied throughout the country. The general introduction of fast motor-traffic which has been instrumental in raising the lighting requirements in cities, has also had a great influence on conditions on many connecting roads and arterial thoroughfares from one city to another. In future the treatment of such main routes in regard to lighting will also require careful study, and here again it is most important that developments should proceed on some ordered plan. Experience during the war showed the advantage of submitting to central control in order to attain uniform procedure in regard to lighting throughout London. Might we not take advantage of this experience in time of peace ?

LEON GASTER.

TRANSACTIONS

OF

The Illuminating Engineering Society

(Founded in London, 1909.)

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

RECENT DEVELOPMENTS IN ILLUMINATING ENGINEERING.

(Proceedings at the opening meeting of the Illuminating Engineering Society held at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C., at 8 p.m., on Tuesday, November 15th, 1921.)

THE opening meeting of the session was held at the House of the Royal Society of Arts on Tuesday, November 15th, the Chair being taken by THE PRESIDENT (Mr. J. HERBERT PARSONS, C.B.E., F.R.S.).

The Minutes of the last meeting having been taken as read, the HON. SECRETARY presented the following names of new applicants for membership:—

Bird, W.	Director of the Engineering & Lighting Equipment Co., Ltd., Sphere Works, ST. ALBANS, Herts.
Langton, W.	Electrical Contractor, 9, High Street, BURTON-ON-TRENT.
Sandeman, W. J. ..	Distributing Engineer and Sales Manager, Croydon Gas Company, Katharine Street, CROYDON.
Talbot, H.	General Manager, Welsbach Light Co., Gray's Inn Road, LONDON, W.C.
Wells, G. J.	Director, Engineering & Lighting Equipment Co., Ltd., Sphere Works, ST. ALBANS, Herts.

The HON. SECRETARY (Mr. L. GASTER) then presented the customary **Notes on Events during the Vacation.** Reference was made to reports recently issued by various Government Committees, including the Third Interim Report issued by the Departmental Committee on Lights on Vehicles, the Second Interim Report of the Departmental (Home Office) Committee on Lighting in Factories and Workshops, and the report issued by the Committee, working under the Ministry of Health, on the effect on vision of lights used in kinema studios. These reports were of interest as illustrating the attention now being paid to lighting problems

by Government Departments and dealt with matters that had been the subject of discussion at meetings of the Society. Mr. Gaster also referred to the First Technical Session of the International Illumination Commission, held in Paris in July, as an important event illustrating the resumption of international treatment of illumination.

In the absence of Mr. S. H. Callow (Chairman) the Report of the Committee on **Progress in Electric Lamps and Lighting Appliances** was presented by Mr. J. F. CAINE. It is stated in the report that difficulties in manufacture recorded at the opening meeting in 1920 have now been largely overcome, and that ample stocks of lamps are available. Progress has also been made in the supply of fittings, especially those for gasfilled lamps of small candlepower, some shortage of which was reported last year. The corresponding Committee dealing with Progress in Gas Lamps and Lighting Appliances had reported that there were no new developments to record.

Mr. W. J. JONES then gave a demonstration of the **Testing of precious stones by ultra-violet light.** Different varieties of pearls and diamonds obtained from different localities could be distinguished by the colour of the fluorescence, the difference in this respect being apparently due to minute impurities.

Mr. G. CAMPBELL then showed some new types of **Reflectors for industrial lighting,** a feature of which was that a direct view of the filament was cut off within an angle of 17½° below the horizontal, and a distribution of light convenient in works lighting obtained.

Mr. HAYDN T. HARRISON then exhibited and described a **New form of photometer** (Benjamin Lightometer). A small lamp is mounted at one end of a box with white interior and illuminates an opal glass plate, bearing a scale in foot-candles. A grease spot disc travels above this diffusing plate and the point of balance indicates the illumination received by the plate. The apparatus is considered particularly convenient for distribution purposes.

The **Grubb "non-dazzle" headlamp** was then exhibited by Mr. ARMSTRONG, who explained how a sharp division between the bright main beam and the diffused light above a specified horizontal plane is obtained. Mr. W. J. JONES also showed a **New form of headlamp** (the "Whitehead" headlight), designed to reduce glare to a minimum.

Exhibitions of **"Artificial Daylight"** apparatus were given by Mr. S. H. GROOM and Mr. F. E. LAMPLOUGH. The former showed a variety of new models of the Sheringham Daylight, and referred to several developments, notably the use of improved pigments that had enabled the efficiency to be approximately doubled. Mr. Lamplough showed a lighting unit equipped with the latest type of Chance's daylight glass, and demonstrated the effect of working with a spurious form of "artificial daylight."

Mr. H. A. CARTER exhibited some of the **New neon gas lamps** fitting into an ordinary holder on a 200—240 v. supply and designed with luminous electrodes in the form of letters suitable for making up signs and notices. Mr. E. T. RUTHVEN MURRAY showed some newly-designed models of his signs brought before the Society last year, a new feature being the adoption of methods of producing pleasing colour-combinations. Finally Major AMCOTTS briefly described the **Luminor sign** which utilises small convex mirrors, capable of focusing either natural and artificial light and appearing as bright objects amidst dark surroundings.

After a brief discussion and the passing of a vote of thanks to those exhibitors, the CHAIRMAN announced that the **next meeting** would take place on **December 13th,** when a discussion on **"Progress in Gas Lighting in relation to Illuminating Engineering"** would be opened by Mr. W. J. SANDEMAN of the Croydon Gas Company.

NOTES ON EVENTS DURING THE VACATION.

By L. Gaster (*Hon. Sec.*).

(Presented at the opening meeting of the Illuminating Engineering Society held at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C., at 8 p.m., on Tuesday, November 15th, 1921.)

It is customary at the first meeting of the Session to give some account of progress during the vacation. The arrangement whereby the Presidents of kindred bodies become Members of Council of the Society during their tenure of office now applies to the following bodies, whose co-operation continues to be of service in dealing with problems of mutual interest :—

The Illuminating Engineering Society in the United States; the Illuminating Engineering Society in Japan; the Institution of Gas Engineers; the Institution of Electrical Engineers; the Council of British Ophthalmologists; the Ophthalmological Society; the Physiological Society; the Electrical Contractors' Association; the Society of British Gas Industries; and the Association of Railway Electrical and Telegraph Engineers.

Three additions have been made to the Council of the Society, namely, Mr. A. Blok, Mr. S. H. Callow, and Mr. W. J. Liberty. I regret to record the death of two members who were associated with the Society in its early stages, namely, Mr. O. P. MacFarlane, who served on the Council up to the present year, and Mr. Chas. W. Hastings.

The various Joint Committees of the Society have been continuing their work, and the recently-formed Joint Committee on Kinema Studio Lighting has been reviewing its field of operations. An official report issued by the Committee working under the Ministry of Health, on the subject of the effect on vision of lights in kinema studios, is of interest in this connection. The report, which has already been summarised in the official organ of the Society,* in many respects confirms the views expressed in the discussion before the Society in January last, and, in conclusion, refers with approval to the action of the Society in forming a Joint Committee to study technical problems involved in kinema studio lighting.

Another question that has been receiving much attention from the Society, *i.e.*, the possibility of eliminating glare from motor-headlights, is also treated in a Third Interim Report issued by the Departmental Committee on Lights and Vehicles. The recommendations made in the report are also substantially in accordance with views expressed in discussions before the Illuminating Engineering Society, notably in regard to limitation of light below a horizontal plane 4 ft. above the ground, with a view to avoiding glare in the eyes of approaching drivers or pedestrians.

These recommendations will doubtless receive attention from the Joint Committee of the Illuminating Engineering Society dealing with motor headlights.

Much attention continues to be devoted to industrial lighting. The second interim report now presented by the Departmental (Home Office) Committee on Lighting in Factories and Workshops forms a useful supplement to that issued in 1915, and is devoted mainly to the requirements to be fulfilled in regard to glare, shadow and constancy of lights.

An appendix to the report contains a summary of clauses in the codes of certain American States, and in recommendations made recently by the Illuminating Engineering Society in Germany, bearing on the points considered. The recommendations in this report will form a useful subject for discussion before the Society, with a view to full elucidation of the various points raised.

Industrial lighting formed the subject of discussion at the recent annual meeting of the German Illuminating Engineering Society and at the Fifteenth Annual Convention of the American Illuminating Engineering Society, when a variety of interesting papers was submitted. Recent researches in the United States appear to establish the direct relation

* Illum. Eng., Sept., 1921, pp. 179–180.

between lighting and efficiency of work. Actual records of time consumed in various industrial operations, by the original and improved illumination, are presented in an article by W. Harrison, O. F. Haas, and F. E. Dopke.* A general increase in production of 12·2 per cent., with an increased expenditure on lighting equivalent to only 2½ per cent. of the wage-bill, is recorded.

A gratifying illustration of the restoration of co-operation on the part of experts in different countries is afforded by the First Technical Session of the International Illumination Commission, which took place in Paris during July 4th—8th. A resolution was passed endorsing the adoption of the international candle—the unit already in use in this country, France, and the United States—and a tentative series of definitions of the chief photometric quantities has also been framed. This was the first occasion on which a series of technical papers has been submitted to the International Illumination Commission, practical questions arising in connection with industrial lighting and motor-headlights, as well as photometric problems being dealt with. As a result of these discussions international technical committees dealing with Photometric Definitions and Symbols, Heterochromatic Photometry, Motor Headlights, and Industrial and School Lighting, are being formed. This step will doubtless be useful in paving the way for international agreement on many outstanding questions, notably the problem of devising ultimately international codes relating to the lighting of factories and schools, headlights for motor vehicles, etc.

The next meeting of the International Illumination Commission has been provisionally fixed to take place in the United States in 1924, and by that time much useful information will doubtless have been acquired by these various Committees.

* *Elec. World*, Oct. 15th, 1921.

THE POSITION OF THE METAL FILAMENT LAMP AND FITTINGS INDUSTRY AT THE PRESENT TIME.

(Report of the Committee on Progress in Electric Lamps and Lighting Appliances [Mr. S. H. Callow (Chairman), Mr. J. E. Edgecombe, Mr. J. W. Elliott (Secretary), Mr. J. Y. Fletcher and Mr. F. W. Willcox]; presented at the meeting of the Society held at the House of the Royal Society of Arts, at 8 p.m., on November 15th, 1921.)

THE position in the electric lamp industry to-day is very considerably altered compared with what it was twelve months ago. The industry can now provide for all demands and requirements for the home market, and in addition is in a position to handle, and is handling, a much larger percentage of the export business.

Lamps.—Manufacturers are now in an excellent position with regard to stocks and most standard types of lamps are obtainable for immediate delivery. Electric lamps are coming into more general use. This is more particularly noticed in the case of signs, the use of which is extending considerably, and the quantity of lamps utilised for such purpose is very great. As regards raw material, provision for the manufacture of bulbs and tubes of excellent quality is forthcoming, and the industry is not dependent on foreign supplies.

The lamp manufacturers have been busily engaged in research work with a view to placing in the hands of the consumers electric lamps of the highest efficiency compatible with a reasonable life, this being of special importance in view of the high cost of current. A year ago it was announced that a new range of gasfilled lamps had been placed on the market, namely, 100—130 volt, 40 watt, 200—260 volt, 60 watt. Further improvements in manufacture have been introduced by which still lower wattages will shortly be placed on the market. Such new sizes of gasfilled lamps with concentrated filaments should meet the requirements for very many special purposes besides the ordinary domestic

lighting. So far, gasfilled lamps have not been used in a general way for domestic lighting, but no doubt these lamps of low wattage will be in general requisition for this purpose.

Specialities such as candle lamps, double-ended tubular lamps for window lighting, etc., are now easily obtainable from the chief manufacturers, and in many cases can be supplied from stock.

Fittings.—During the past 12 months electric light fittings manufacturers have been working in close co-operation with the lamp manufacturers in the design and adaptation of fittings to suit the various sizes of gasfilled lamps now on the market. We had occasion in a previous report to admit the difficulty of procuring suitable scientific reflectors for use with the lower wattage gasfilled lamps, this leading in many cases to such lamps being used for shop window lighting, etc., without any shade or reflector, thereby producing glare and causing considerable eye-strain to passers-by inspecting goods displayed in the window.

There are to-day several well-known lines of scientific reflectors and shades on the market covering all types of gasfilled lamps so that there is now no excuse for the use of bare lamps. The variety of selection is now wide, as will be observed from the illustrated designs which have been brought to the notice of the trade from time to time during the past twelve months. Here again in most cases stocks are available and immediate delivery of most standard types can be effected.

EXHIBITS ILLUSTRATING PROGRESS IN ILLUMINATING ENGINEERING.

Fluorescence of Gems by Ultra-Violet Light.

MR. W. J. JONES mentioned that a number of uses had recently been found for ultra-violet light such as the sterilisation of water, their application in therapeutics, and recently to the more definite study of fluorescence of pearls and precious stones.

The apparatus exhibited comprised a source of ultra-violet light of great intensity, namely, an electric arc with electrodes of tungsten. The radiation passed through an ultra-violet screen, which filtered out all waves excepting those in the violet and ultra-violet regions of the spectrum.

The first object tested was a necklace of Indian pearls which was seen to fluoresce with a *bluish* colour. Next a number of Japanese cultured pearls were subjected to the ultra-violet light and were seen to fluoresce a *mustard green* colour. Mr. Jones added that it had been known for some time that diamonds were capable of fluorescing in ultra-violet light, but it would appear from investigation that the colour of fluorescence was in some measure dependent upon the origin of the diamonds. A number of gems which appeared similar in ordinary daylight fluoresced totally different colours under the action of ultra-violet radiation. For instance, the river-bed diamonds appeared a dark brown, whilst the diamond fluoresced ultra-marine, and the fine diamond from a Brazilian mine appeared an even brighter blue, whilst yet another diamond from an unknown source appeared yellow.

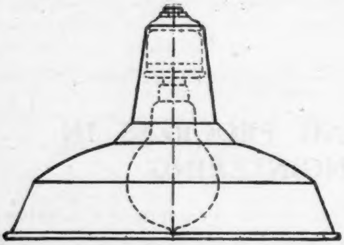
It was suggested that these different colours were due to some minute trace of foreign substance which was characteristic of the locality where the diamonds are found. In conclusion, Mr. Jones expressed his indebtedness to the owners of the Swanson Ultra-Violet Lamp for the loan of their instrument, and to Mr. Hooker for so kindly exhibiting such fine specimens of diamonds which made the demonstration possible.

The effects observed would naturally require study by experts in order that they might be properly interpreted in examining gems. There were many other materials which would show fluorescence under ultra-violet light and no doubt this method of analysis would have other applications.

New Types of Industrial Lighting Reflectors.

MR. G. CAMPBELL explained that the chief features of these new Benjamin R.L.M. standard dispersive reflectors were the better screening of the filament from the eye and more efficient distribution of light. Gasfilled lamps in general yield a concentrating curve of light distribution which requires considerable modification when extensive distribution is needed. Shallow reflectors have hitherto been used for this purpose, with the result that the filament is incompletely screened from view.

The reflectors exhibited were of porcelain enamelled steel and could withstand



ordinary handling without losing shape or suffering damage. The surface of the reflector was so designed that with standard lamps the filament was cut off from view at an angle of $17\frac{1}{2}°$ below the

horizontal. This came very near to the recommendation of the Home Office Departmental Committee on Factory Lighting, viz., that the angle of cut off should be 20°; in practice this small difference was not discernible, but the angle of cut-off could be increased if desired.

The diameters of reflectors ranged from 10 in. to 20 in., according to the size of the lamp used and the contour was such as to avoid undue concentration of light below the lamp. Photometric tests showed that the maximum candlepower, between 0° and 15° from the vertical axis, does not exceed by more than 15 per cent. the average of candlepower values at 25°, 35° and 40°. A high efficiency was obtained, approximately 70—75 per cent., of the output of light from the bare lamp being distributed.

These new reflectors were particularly suitable for use with gasfilled lamps in industrial lighting, especially in view of the smaller lamps coming into general use, with a view to eliminating glare. A section of the reflector and the polar curve are shown in the accompanying illustrations.

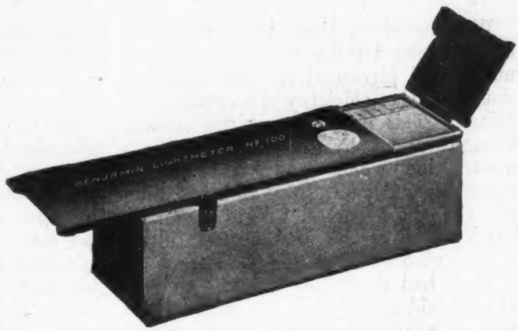
A New Illumination Photometer.

The Benjamin Lightmeter was described by Mr. HAYDN T. HARRISON, who is the inventor of this simple but effective little piece of apparatus. Mr. Harrison apologised for introducing another portable photometer, as there were already many, but he felt that as our last President, Mr. A. P. Trotter, was responsible for the first, he could not follow in better footsteps.

The simple piece of apparatus which he exhibited might not be called a sample of scientific apparatus, but had a more commercial value inasmuch as it made it possible for anybody, at a small expense, to check the results which it was necessary to obtain in order to ensure that the illumination was equal to that specified by the authorities for the particular purpose under consideration. The chief advantages of the particular form of apparatus exhibited were that the photometric balance could be obtained by a general observation and not by inspection through an eye-piece which was liable to lead to eye strain resulting in reduced accuracy.

Mr. Harrison pointed out that the main feature, consisting of a translucent screen illuminated to varying degrees by a small electric lamp, had been used before by various experimenters, the novel feature being the use of a moving screen above the main screen. This was on the Bunsen principle, consisting of a translucent central part with an opaque albido surface surrounding it, a very

accurate balance was obtained by moving the sliding cover in which this screen was mounted until the translucent portion disappeared; the illumination in foot-candles could then be read off the scale above through the small opening provided for the purpose.



The stock pattern of instrument exhibited was provided with a scale 0·5 to 20 foot-candles which covered nearly every requirement of interior artificial lighting; special scales were provided when necessary for dealing with low illumination such as street lighting, or very high illumination sometimes encountered in daylight.

Recent Improvements in the Sheringham Daylight.

Mr. S. H. Groom recalled the principle of the Sheringham Daylight, as explained before the Society last year. The method adopted differed from that of all other daylight units in employing reflection instead of transmission in order to reduce the energy of the various wave-lengths present in an artificial source to the same relative proportions as in daylight.

The energy curve of the light obtained after reflection from a given pigment (a matt surface being employed) could clearly be found by multiplying the ordinates of the energy curve of the source by the corresponding ordinates of the reflection curve of the pigment. Similarly, by division one could determine the ideal reflection curve for a pigment which would convert light with a known energy distribution into light with another known energy distribution.

The source of light employed up to the present had been the gasfilled lamp, and no single pigment had been found which would bring about the desired conversion. By utilising more than one pigment, however, in definite proportions by area, a shade could be produced whose reflection characteristics as a whole closely approach the ideal, and the combined effect of the matt surface and the small size of the individual patches of pigment resulted in quite satisfactory mixing of the reflected light. An under-reflector was used on all the units, which served the double purpose of giving increased illumination on the shade and cutting off all uncorrected light.

When the last report of progress was read before this Society a year ago, the initial difficulties had been overcome, one of the most important of these being the discovery of a suitable medium for use in mixing the pigments. The light was found to give general satisfaction, and most of the objections raised related to quantity rather than to quality. Apart from the question of efficiency, in the narrow economic sense, there was no doubt that the attainment of a certain minimum degree of illumination was as essential for colour-matching purposes as is spectral quality itself, and efforts were therefore concentrated on improvements in efficiency.

As had been frequently pointed out, the production of a true daylight from artificial light sources at present available necessarily involved a sacrifice of about 80 per cent. of the original light, and therefore to claim that one was getting 50 or even 30 per cent. efficiency was to state that one is *not* producing true daylight. In order to get the maximum possible efficiency within the limits set by the necessity for correct quality the shade should reflect 100 per cent. of the light of that wave-length whose energy is a maximum in the daylight spectrum.

In our case, therefore, the problem became one of finding brighter pigments which could be so employed that the mean reflection curve of the whole shade was of the same form as in the earlier units, but higher throughout the whole spectrum.

Working along these lines, they had now succeeded (after examining a large number of pigments) in approximately doubling the efficiency previously obtained. This improvement was mainly brought about by the use of a light ultramarine which was an extremely pure blue and had a very high reflection for the short waves. This was now employed in place of the dark ultramarine used in the earlier shades.

They had now, also, a better quality of emerald-green, and by mixing this with a special medium in place of oil obtained a still greater improvement.

A small area of yellow had also been introduced to improve the quality of the light, and owing to the very high reflection of this pigment, especially for waves near the brightest region of the spectrum, this had had a marked effect on the efficiency.

No fundamental changes in the shape of the shade have been made, but several minor refinements have received attention. Thus the new models were provided with a ball-jointed focusing top which allows the lamp to be adjusted laterally as well as vertically—an important modification, as it was desirable that the whole of the shade should be illuminated without any side beam being allowed to escape. The general finish and appearance of the units had also been very much improved.

Coming to the exhibits on view, Mr. Groom showed a table standard lamp suitable for drawing-room or library use; there was also a small industrial unit for general colour-matching purposes, while a third exhibit comprised a Sheringham unit and an ordinary bulb with white reflector, mounted on the same stand in order that the appearance of fabrics under both lights in succession might be rapidly demonstrated.

The other two units provided free adjustment in all directions, and had been designed for the use of the dental and medical professions.

Other units not shown included troughs for the illumination of large areas and shades suitable for the illumination of pictures in art galleries, etc. One of the large troughs taking three 300-watt lamps had recently been purchased by a well-known printing firm for use in connection with the printing of banknotes.

The commercial development of Artificial daylight units had revealed the fact that a larger number of industries than one would have suspected depend for their efficiency upon colour-matching. Thus, in addition to its more obvious uses in dye manufacture, textile printing, art schools, etc., artificial daylight had been found of the greatest possible use in the grading of flour, rubber, tobacco and fur.

Chance's Daylight Glass.

Mr. F. E. Lamplough explained the use of the special Chance Daylight Glass in producing artificial daylight. As was evident from the exhibit, the glass was introduced below a gasfilled lamp equipped with a suitable opaque reflector, enabling good downward concentration of light. The light emerging through the disc of tinted glass had properties very closely resembling those of natural daylight for colour-matching purposes, and it had been used with success by well-known firms of dyers in very accurate work. There had recently been a shortage of such glass, but there was now available an ample supply of the latest variety.

Where very great accuracy was desirable a still more exact reproduction of daylight could be secured by coating the interior of the reflector with a suitable blue pigment. This enabled a somewhat thinner glass to be employed, so that the overall efficiency attained, approximately 40 per cent., was very slightly affected.

Mr. Lamplough then proceeded to demonstrate the qualities of artificial daylight by aid of a cabinet with three partitions. In one of these a daylight unit, designed as described above, was introduced. A second partition contained an ordinary gasfilled lamp in reflector, while the third partition was occupied by a similar lamp, equipped with a disc of blue glass producing light which apparently resembled daylight, but in reality had quite different properties as regards the appearance of coloured objects. Certain dyed fabrics could be obtained which appeared to match under daylight, but did not do

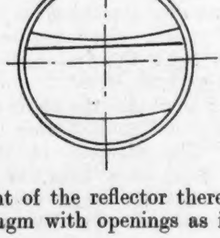
so under the light of an uncorrected gasfilled lamp. Conversely one could select shades of colour which appeared identical by the artificial light, but were quite dissimilar in daylight. By introducing such specimen colours in turn under the true artificial daylight and the spurious variety, Mr. Lamplough showed that their relative appearance was quite different. The conclusion was that one must not be misled by an apparent resemblance to daylight of light yielded by a lamp equipped with some bluish glass. Its true value for colour-matching was only revealed by exact tests on materials and it was quite easy to produce such an apparent resemblance without in the least solving the fundamental problem of obtaining a light which revealed colours with fidelity.

The Grubb "Non-Dazzle" Headlamp.

Mr. ARMSTRONG, with the aid of a battery kindly loaned for the occasion by Messrs. C. A. Vandervell and Co., Ltd., demonstrated the working of the Grubb headlamp by projecting the beam of light on the screen and pointing out the sharp line of division between the bright driving beam and the subdued upper portion. This line of division enabled a bright light to be concentrated on the roadway and approaching vehicles without dazzling of the eyes of pedestrians and approaching drivers.

The lamp was constructed substantially as follows :—

The rear part (behind the joint) contains a silvered reflector of parabolic or preferably elliptical section. An electric bulb is fixed in this reflector in such a position that the reflected rays are projected forward in a slightly converging beam.



In front of the reflector there is fixed a diaphragm with openings as in Fig. 1

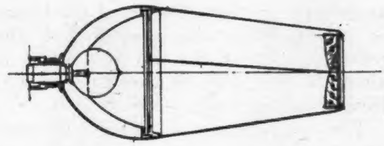
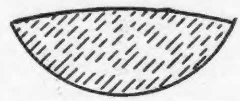


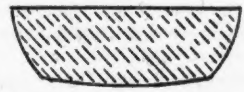
Fig. 1.—Section of Grubb Headlight.

dividing the beam into two sections. In front of this diaphragm and at a distance from it, approximately equal to their focal lengths, are fixed two projecting lenses, one opposite each of the two sections. A longitudinal diaphragm is fixed between the first-named diaphragm and the lenses, so as to confine the rays from each portion of the reflector to its respective projecting lens.

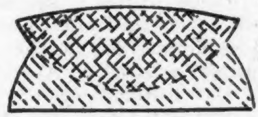
The projecting lenses are so formed that the projected images of the two exposed portions of the reflector are superimposed, with their upper edges coincident. The image of each portion is formed upside down, that of the upper half appearing thus :—



and that of the lower portion thus :—



When the images are overlapped they appear thus :—



The construction of the lamp is such as to form two complete optical projecting systems, the upper forming an image of the upper aperture in diaphragm, and the lower an image of the lower aperture and the optical parts are so assembled that one image overlaps the other to a large extent and therefore gives double the brilliancy in the essential parts of the illuminated area. As made

at present, the focal length of the lenses is about twice the aperture of the reflector, so that the width of beam is about 50 feet wide at a distance of 100 feet, or one in two.

The lamps can, of course, be constructed to give a narrower and consequently a more intense beam, by using lenses of greater focal length, or *vice versa*.

The Whitehead Headlight.

Mr. W. J. JONES, in demonstrating this new device, remarked that the question of the design of a suitable headlamp which would give sufficient driving light without glare was one which the Society had considered upon several occasions during the last two to three years.

The comprehensive papers by Mr. Walsh and Major A. Gerrard dealt with the matter generally and described various attempted methods of eliminating glare or minimising its effect.

Mr. Whitehead had designed a new form of headlamp, which possessed several novel features, inasmuch as it was aimed to provide a broad projected beam capable of giving ample distance vision *without* serious glare. This had been accomplished by altering the curvature of the ordinary parabolic reflector, so that the reflecting surface obtained is not that simply described by the revolution of a parabola.

A section through the headlamps (Fig. 1) showed that the upper part of the lamp was slightly different in curvature from the bottom. The upper part had been dished, so that it was inclined to the main axis of the lamp. The result of this procedure was that the light which was ordinarily collected by the bottom part of the reflector was projected almost parallel in the usual way and the light which under ordinary circumstances formed the top half of the beam was slightly inclined, so as to overlap the lower half of the beam.

The effect was that the light was not radiated from the top half of a lamp to any extent in an upward direction such as would enter the eyes of pedestrians and that the light was almost entirely horizontally projected.

It would be noticed that a section of

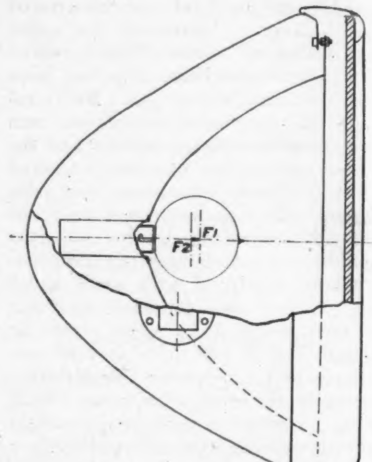


Fig. 1.—Section of Whitehead Headlight.

the resulting beam was that of a semicircle. It owed part of its intensity to the lower part of the reflector and part to the superposition of the beam from the upper part of the reflector.

The designer had aimed at producing a broad beam, and a road test with a Lumeter gave the following results:—

Lamp 24 watt gasfilled Siemens Britannia.

At 50 yards	.. ..	0·725 f.-c.
At 60 yards	.. ..	0·585 f.-c.
At 100 yards	..	0·125 f.-c.

Test card two feet from the ground.

The angle of the beam was sufficiently wide to cover 30 feet at 50 yards and gave ample illumination of hedges. The road test with this unit showed that a good driving light was obtained which is capable of giving visibility for more than 100 yards ahead. This was due to the extremely powerful central portion of the beam.

The amount of dazzle was inappreciable and the nearer one approached the source of light the less noticeable it became.

In order to obtain the above results a special form of gasfilled lamp had been designed. The filament of the lamp took the form of a helix, as is often employed, but the turns were concentrated at one end. The best focus was

obtained at the point of junction of the closely-wound turns and the extenuated turns.

It would thus be seen that this headlight possessed great efficiency and instead of eliminating the upper half beam, as in some anti-glare fittings, used its light to enhance the lower half beam and, with, perhaps, a few modifications, should have great possibilities.

Discharge (Neon) Lamps.

Mr. H. A. CARTER, in exhibiting some of the new " discharge " lamps, based on the luminescence of neon gas, said that from the earliest days of electric lighting a demand had existed for lamps of low consumption for use where only a dim illumination was needed. The problem of producing such a light had proved difficult. There were at present limitations to the diminution in size of lamps using filaments, and until recently it had been customary to use the smallest available, 20 watts, and to dim its light by dense opal glass, silk or other diffusing media.

Requirements had now been much more satisfactorily met by the introduction of the " neon " or " discharge " lamp, which consumed only 5 watts on 200—250 volts. The principle of the lamp could be best understood by considering the effect observable when a potential of a few hundred volts was applied to two electrodes sealed into a cylindrical glass tube containing gas at a low pressure of about 1 mm. of mercury. One observed (A) a comparatively dark space known as the Crookes' dark space surrounding the cathode; (B) a luminous region called the " negative glow." This was sharply defined at the side nearer the cathode, but was more indefinite at the other side where it merged into (C), a second dark region, known as the " Faraday dark space." The remainder (D) of the space was filled by a luminous column of gas extending to the anode, and known as the " positive column." Under suitable pressure conditions this appeared as alternate light and dark sections called striations.

The widths of the dark spaces and the negative glow varied with the nature of the gas and its pressure. When a certain degree of exhaustion was reached the negative glow filled the greater part of the tube.

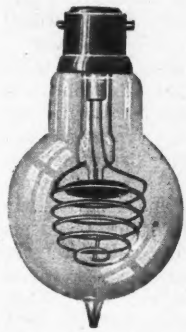


Fig. 1.—" Lighting Type."

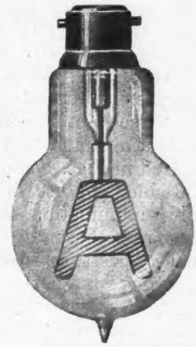


Fig. 2.—" Letter Type."

Types of " Discharge Lamps."

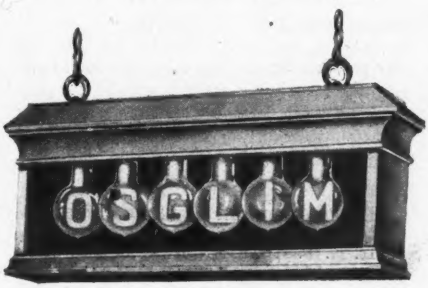


Fig. 3.—Showing arrangements of " Discharge Lamps " to form letter sign.

The " Discharge Lamp " depended for its luminosity on this negative glow, the pressure being so adjusted that the glow appeared as a layer of luminous gas a few millimetres thick, on the surface of the cathode. The lamp was available in both a.c. and d.c. patterns, which should be specified when orders were placed. In the d.c. type the light was emitted from one electrode only—the anode remaining dark—but in the a.c. type light was emitted from both electrodes simultaneously. While a d.c. lamp could be used on an a.c. circuit, or *vice versa*, the lamp should be used on the circuit for which it was marked in order to obtain maximum efficiency; on d.c. circuits the lamp should be inserted into the lamp-holder in such a way that the correct polarity was observed, though

the lamp would not be damaged in any way if incorrectly inserted, but would merely fail to give the full brightness.

At present lamps were only suitable for use on voltages of 200—250 volts, and were made in two distinct patterns—the "lighting" and "letter" types—as illustrated in Figs. 1 and 2. The former was intended for use in cases where only a dim illumination was needed, *e.g.*, in nurseries, hospitals, dormitories, kinema halls, passages, porches, etc. In the "letter" lamp the cathode was varied to form various letters of the alphabet, etc., and was intended for use with illuminated signs, direction indicators and similar purposes, as illustrated in Fig. 3.

Discharge lamps could also be effectively used as pilot lamps, as circuit indicators on switchboards, for testing the polarity of d.c. circuits, and for ascertaining whether a circuit was of the a.c. or d.c. type. In conjunction with a ruby glass they would also serve as a safe and economical light for dark-rooms.

Developments in Luminous Signs.

Mr. E. T. Ruthven Murray exhibited some developments of the luminous signs which he had shown before the Society at the opening meeting of the last session. It would be recalled that these signs were based on the use of concealed tubular lamps above a plate of clear glass, on the back of which appropriate lettering was engraved. Such letters stood out brightly illuminated. The tube concealing the lamps from the view of observers outside the window of a shop had now been provided with an adjustable reflecting strip, which allowed light to pass backwards, the sign thus serving to illuminate objects behind it, as well as showing the bright device in letters. Signs of this latter type could be conveniently stood on counters, etc., facing the customer.

Mr. Murray also exhibited a sign bearing on its back a coloured picture (a reproduction of the well-known placard, "His Master's Voice"). The colours of pictures engraved on the back of the glass stood out very vividly.

Other novel devices had for their object the display of changing colours. By adopting lamps with suitable colour-screens at top and bottom of the glass pleasing combinations of tints could be produced, and these could be varied in any desired manner by the use of automatic "flashers."

Luminor Signs.

Major W. C. Amcotts, R.E., explained that the "Luminor" signs were "lightless" in the sense that they were not provided with lamps to produce a luminous effect, but were dependent merely on the light that was furnished by the sky or by artificial lighting sources that happened to be in their vicinity.

The essentials of such signs were that (1) they should reflect rays from a wide angle of incidence, (2) they should absorb a minimum of light, and (3) the reflective surfaces should not tarnish nor be affected by weather, dirt, smoke or fog.

The Luminor sign, designed to comply with these conditions, utilised a series of highly-silvered mirrors embedded in letters of reinforced concrete, in such a way as to adhere firmly and be proof against the entrance of moisture behind them. The convexity of the mirrors gave a wide angle of reflection and resulted in minimum absorption of light. Their shape prevented undue accumulation of dust, and the glass was practically unaffected by fog. Such signs, with letters or devices outlined in embedded convex mirrors, would wear for years, even in the most exposed conditions. Some erected in Paris in 1914 were still as good as when they were put up. The manufacture of the signs had been revived after the war, and they were widely used in Paris and elsewhere.

Amongst the many fields of use for the signs might be mentioned :—

Station names and notices, where the lighted windows of trains were sufficient to make the letters visible even at a considerable angle.

Road signs, *e.g.*, direction posts, speed limit notices, danger triangles, etc., which could be read at a distance of 500 yards by the light of a headlamp.

Street names, house numbers, shop signs and advertisements, which would show up by the light of street lamps or light from opposite buildings.

During the summer, luminor bulbs could be inserted in place of bulbs in electric signs, enabling these to be utilised with effect and economy in the long daylight hours. For interior use, letters might be made in wood or plaster, and would shine out even in dimly lighted passages. Hence, they appeared particularly suitable for use in kinemas. Changeable signs mounted at the entrance to picture palaces should prove useful for indicating changes of programme, etc.

In conclusion, Major Amcotts exhibited a small Luminor letter with all the lights extinguished except a small glow lamp in order to illustrate the effect in semi-darkness.

(DISCUSSION.)

Mr. W. T. LIBERTY expressed his interest in "Luminor" signs and referred to a non-luminous glass sign reading "Drive Slowly," which he had fixed in Queen Victoria Street. This was found quite effective with ordinary street illumination.

Mr. E. T. RUTHVEN MURRAY asked whether the scenes at the Hippodrome in which special lighting effects were obtained had any connection with the variable colours obtained under daylight glass and with ordinary artificial light.

Mr. F. E. LAMPLOUGH replied and explained that the effects at the Hippodrome were obtained by using monochromatic lights alternately which necessarily showed up certain colours only.

Mr. A. BLOK referred to the photometer exhibited by Mr. Haydn T. Harrison, and thought it might possibly make the reading easier if a portion of the exposed luminous part of the apparatus could be covered over so that the eye was not distracted when judging the balance. He also mentioned that a device somewhat similar to "Luminor" signs, but in which glass hemispheres were used, was developed during the war for the purpose of showing up tanks, etc., in comparative darkness. He asked whether it was found necessary to clean the glass in "Luminor" signs frequently.

Major AMCOTTS stated that with letters in the open no special cleaning was required, wind and rain doing all that was necessary.

Mr. HAYDN T. HARRISON inquired whether there was an appreciable emission of ultra-violet light in the "Neon" lamp.

Mr. CARTER was unable to say definitely what was the proportion of ultra-violet rays but offered to get figures. He conjectured that the proportion must be very small, as the visible spectrum was practically confined to the red and orange.

Mr. F. J. HAWKINS (*communicated*):—Referring to the demonstrations by Mr. W. J. Jones, of the effect of ultra-violet light on gems it may be of interest to mention that we have supplied a large number of ultra-violet outfits fitted with mercury burners for jewel testing, and particularly in connection with the sorting of Japanese from the ordinary oriental pearls. The outfit comprises a quartz mercury lamp fitted in a special cabinet which is provided with a window made of special ultra-violet glass, this glass being transparent to ultra-violet rays, and cutting off the visible spectrum. Japanese pearls fluoresce a saffron colour under these rays, whilst the ordinary oriental pearls fluoresce blue.

The discovery of this method of discriminating the two varieties of pearls was made about nine months ago by Dr. Herbert Smith, of the Natural History Museum, working on the subject at the request of Mr. Hopkins of the Pearl and Pecious Stone Section of the London Chamber of Commerce, though we might add that the discovery was also made independently shortly afterwards by a member of our own technical staff.

Mr. Hopkins has very kindly supplied to us the attached photographs, showing magnified sections of cultivated and natural pearls, the mother-o'-pearl centre in the cultivated type being clearly shown, whilst it will be noticed that the natural pearl is made up in a larger number of layers.

As was pointed out at your meeting, various other types of jewels can be sorted under ultra-violet light, and cabinets such as are manufactured by us are therefore extremely useful to those dealing with precious stones.

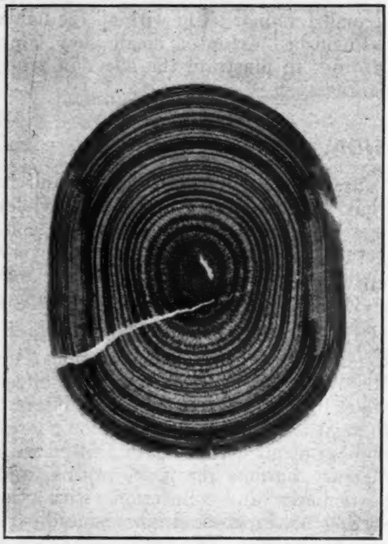


Fig. 1.—Section of Natural Pearl.

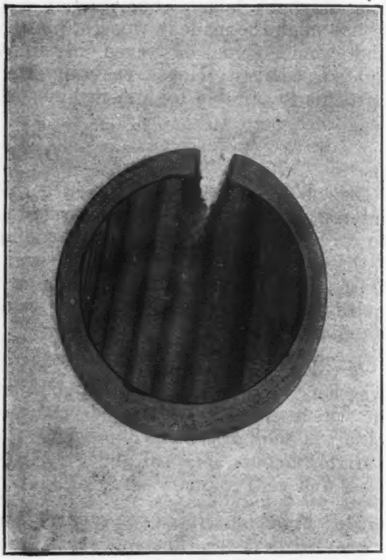


Fig. 2.—Section of Japanese Cultured Pearl.

INDUSTRIAL ILLUMINATION.

A lecture on the above subject was delivered before the Belfast Association of Engineers on November 17th by Mr. G. Herbert, who emphasised the important bearing of adequate lighting on the efficiency of the worker. A worker, he remarked, does as much with his eyes as his hands, and can only turn out a good job if he can see exactly what he is doing. Besides having this important bearing on efficiency of production, good lighting is conducive to greater cheerfulness of workers.

Mr. Herbert then proceeded to discuss the main elements in scientific lighting, dwelling on the avoidance of glare and the distribution of light from modern reflectors. Methods of planning installations were summarised, and importance was attached to ease of maintenance and moderate operating and initial costs.

A good discussion followed, and a vote of thanks to Mr. Herbert, proposed by Mr. Atholl Blair and seconded by Mr. Thos. Gibson, terminated the proceedings.

Obituary.

MR. JOHN GIBSON.

The many friends of Mr. John Gibson will regret to learn of his death (from cerebral hemorrhage), which occurred very suddenly on Friday, December 9th, in London.

In earlier days Mr. Gibson was connected with Messrs. Ernest Scott & Mountain, Newcastle-on-Tyne, and Messrs. Holden & Brooke, Manchester, but for the last 15 or 16 years he was prominently associated with the supply business of the Metropolitan-Vickers Electrical Co., and was a director of the "Cosmos" Lamp Co.

He leaves a widow and three children, to whom our sympathies go out in their sudden bereavement and heavy loss.

The funeral took place on Wednesday, December 14th, at 12 o'clock, in the Peel Green Cemetery, near Eccles.

PUBLIC LIGHTING

A PAPER on the above subject, by Dr. J. S. G. Thomas and Mr. Dean Chandler, of the South Metropolitan Gas Company, was read at a conference arranged by the Institution of Gas Engineers at the Public Works, Roads and Transport Congress at the Royal Agricultural Hall on November 18th. Mr. Thomas Hardie, President of the Institution of Gas Engineers, presided.

Dr. Thomas referred to the complexity involved in the many different terms used in illuminating engineering. In regard to public lighting, he suggested that satisfactory service involved (1) adequacy of illumination ; (2) steadiness and constancy of light sources ; (3) absence of glare ; (4) minimum cost compatible with adequate service ; (5) a system such that national fuel resources are conserved to the utmost. Requirement (5) was well satisfied by gas lighting. Cost was usually the crux in deciding public lighting and was affected by many factors—all matters of keen controversy. Some authorities considered that elimination of glare was of greater importance even than amount of illumination provided. Exposure of the eye to bright sources caused a contraction of the pupil aperture, with the result that the eye did not receive the full benefit of the illumination. A table of intrinsic brilliances of illuminants was presented. Sources should be screened by a diffusing medium, or should be placed out of the direct range of vision. Tests in New York in a street, half of which was lighted by sources in diffusing globes, the other half by unscreened similar sources, showed that the conditions in the former case were the better, despite the greater illumination afforded by the unscreened lamps. Reference was made to the recommendations contained in the last report of the Departmental (Home Office) Committee on Lighting in Factories and Workshops, limiting the angle between a line from a source to the eye and the horizontal to not less than 20°. Steadiness and constancy were of obvious importance.

The paper contained the standards of minimum horizontal illumination recommended by the Joint Committee on the Standard Specification for street-lighting, as discussed by Trotter.* At present, however, specifications were almost invariably based on measurements of candlepower.

In order to illustrate progress in the South Metropolitan Gas Company's district, a table was given showing the number of public lamps, candlepower and duty in the years 1899, 1902 and 1913. The number of lamps had increased from 20,998 to 24,713, the candlepower provided from 280,000 to 1,700,000, and the candlepower per cubic foot of gas per hour from 2·5 (with flat flame burners) to 19 with incandescent burners. The Gas Regulation Act afforded a possibility of standardising gas-consuming appliances. Experience in the South Metropolitan Gas Company's area showed that burners without gas or air adjustment could be designed with an efficiency deviating little from the determined value, provided the calorific power of gas did not depart from the declared value by more than ±25 B.Th.U. Work in connection with public lighting involved (1) experimental determination and specification of a burner suitable for use under extreme conditions met with in streets ; (2) assembling of component parts for bulk manufacture of such burners ; (3) verification at intervals of the duty rendered by burners supplied in bulk ; (4) further experimental work with a view to improved efficiency.

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* ILLUM. ENG., May, 1913.

A table, supplemented by polar curves, showed the candlepower per 1/100 therm of gaseous energy derived from several forms of burners. Thus the 14 in. "Windsor" upright Kern street lamp yielded a mean candlepower of 35, and operated at 12·9 candles per cubic foot per hour or 23·4 candlepower per 1/100 therm. The "South London" inverted burner yielded 118 candlepower, and operated at 28·5 candles per cubic foot per hour or 51·8 candles per 1/100 therm; the "South London" 3-light lantern with superheater yielded 229 candles, operating at 36 candles per cubic foot per hour or 65·4 candles per 1/100 therm. The paper was illustrated by numerous views of lanterns and photographs showing modern street-lighting.

In concluding, Dr. Thomas paid a tribute to the work of the Illuminating Engineering Society in bringing about a better appreciation of the benefits of good illumination and encouraging the scientific treatment of street-lighting.

The discussion was opened by Mr. Haydn T. Harrison, who congratulated the South Metropolitan Gas Company on the valuable work done in street-lighting. He would like to know exactly what was meant by the "mean candlepower" mentioned in the paper. He agreed that in 80 per cent. of streets one could not readily measure illumination; but minimum illumination could be calculated from the candlepower, if known. Glare was of great importance. The requirement embodied in the Home Office Departmental Committee's report in regard to angle was satisfactory. He was in favour of keeping lamps high up.

Mr. W. J. Liberty and Mr. Watson emphasised the importance of avoiding glare or sudden contrasts in brightness. Mr. Liberty mentioned several instances of unsatisfactory conditions—notably the sudden changes in brightness liable to prove inconvenient to traffic. He referred to the benefits secured by the use of bracket-lamps and central suspension in the City of London.

Mr. L. Gaster thanked Dr. Thomas for his appreciatory reference to the work of the Illuminating Engineering Society. As regards nomenclature different usages had developed in various countries, but the International Illumination Commission had facilitated agreement on definitions of the three fundamental quantities—Flux of Light, Candlepower and Illumination; others were being studied by a technical committee. Lighting requirements in streets were quite different from those considered adequate in the past, owing to the development of fast motor-traffic. One must avoid sudden changes in illumination, in passing through areas controlled by different authorities, or in turning from main streets into side streets, or *vice versa*. He recommended the supervision of the lighting of London by a suitably constituted central body, with a view to obtaining public lighting on a uniform plan. In this respect we might learn from experience during the war.

Mr. Dow referred likewise to the great importance of avoidance of glare. He inquired whether, in comparing lamps, some differences might be met in different districts according to whether rating in cubic feet of gas per hour or hundredths of a therm were adopted?

Mr. J. G. Clark remarked that a name for the hundredth of a therm was needed. Although in street-lighting illumination was what they needed, candlepower was the best means of determining it, but the angle should be specified. Measurements were of great importance in connection with large contracts. He emphasised the benefits of maintenance by the gas company.

Dr. Thomas briefly replied to the points raised in the discussion, and a vote of thanks to the author of the paper terminated the proceedings.

TOPICAL AND INDUSTRIAL SECTION.

[At the request of many of our readers we have extended the space devoted to this Section, and are open to receive for publication particulars of interesting installations, new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona-fide* information relating thereto.]

AN ATTRACTIVE WINDOW DISPLAY.

A feature of the General Electric Company's Autumn Sales Campaign is the attractive window displays which the company are offering to loan to their clients. Some of these displays exhibited in the windows at "Magnet House," Kingsway, and one designed to advertise Osram Lamps, deserves special notice. It consists of a back cloth and various pieces of scenery, depicting a winter scene in an old English village. By means of hidden lamps the windows in the model houses may be illuminated, thus emphasising the value of comfortable indoor lighting. We understand that the whole apparatus is very simply designed, and can be erected in a very short space of time without any special knowledge.

We are informed that a limited number of these displays are available for loan, application for which should be made on the special form attached to Leaflet O.S. 2619, which also gives full details and instructions for erecting.

"ECLAT" ELECTRIC LAMPS.

At the recent exhibition in connection with the Public Works, Roads and Transport Congress, held at the Agricultural Hall, we observed that a stall was devoted to "Eclat" lamps. This company, it may be noted, began its business in 1919, the managing director being Mr. Edghill, who, we understand, was for some time at the works of the Edison Swan Electric Co., Ltd., and has also been in the service of other lamp concerns. The company undertakes the manufacture of both drawn-wire and gasfilled lamps, the latter being available in sizes from 15 to 1,000 watts.

DISSOLVED ACETYLENE.

At the recent Motor Cycle and Light Car Exhibition at Olympia Messrs. Allen-Liversedge, Ltd., showed a number of devices of interest to motorists, notably the A.-L. Fallolite lamps, based on the use of a pastille of thorium brought to incandescence in a high pressure acetylene flame, and placed at the focus of a parabolic mirror. Dissolved acetylene outfits for use, either with these or ordinary burners, were naturally in evidence. Another exhibit deserving of mention was the Rolph Patent Traffic Warner, by means of which a driver can signal to a car behind him when he proposes to slow down or stop. The words "slow" or "stop" appear in succession in white letters on a red background automatically when the footbrake is operated.

HOLOPHANE ILLUMINATION IN SCHOOLS AND CHURCHES.

Two attractive leaflets issued by Holophane Ltd. contain particulars of a variety of churches in which installations have recently been made and examples of scientific illumination in schools. Among the latter is included the new "Big School" at Haileybury College. Numerous effective photographs of installations, taken entirely by artificial light, are furnished.

We are informed that The Sheringham Daylight Development Co., owing to the large increase in business, has found it necessary to take more commodious premises at 1, Wardour Street, London, W.1. (Tel. No. Gerrard 3828.)

THE LIGHTING OF ST. MARIE'S CHURCH, RUGBY.

An attractive instance of artificial lighting in churches is furnished by the installation at St. Marie's Church, Rugby, a Roman Catholic Church of Gothic architecture. The walls are a very light stone colour, relieved by a decorative design around and between the pointed arches. The roof timbering is blue with silver stars painted upon it.

The present installation at St. Marie's Church consists of Mirolux trough-reflectors containing 40 and 60 watt Mazda vacuum lamps. The nave is lighted by fourteen troughs. These reflectors are fixed on the east side of the arched roof beams, between the clerestory windows. Several advantages attend this disposition of the light units. To begin with, neither the lamps nor reflectors are visible to the congregation. The light comes from the same level as the windows and, like the daylight, illuminates the entire cubic area of the nave, from floor to ceiling. There is an ample illumination at pew height, and the congregation are able not only to read with ease, but also to look towards the chancel without the slightest discomfort.

The chancel is lighted by means of six Mirolux troughs. Owing to the general eastward direction of all the lighting and the greater wattage employed in the chancel, the altar and reredos, and especially the rood cross, are more intensely illuminated than the body of the church. The lighting, as it should do, helps to focus the attention of the congregation upon these three predominantly significant features. This again is simply a night-time reproduction of the daylight effect aimed at by the architect. The photograph illustrating this description was taken at night, solely by the light of the Mazda installation.

To Mr. Shenton, Engineer of the Rugby Urban District Council Electricity Supply, must be accorded much of the credit for this installation. The wiring, which is on the surface, is carried out on the Henley Wiring System, with twin lead-covered cables, painted to match their surroundings. This system, owing to the small section and flexibility of the wires, is very suitable for such an installation as this. The wiring in St. Marie's Church is practically invisible. Control of all points is centralised in a distribution box fixed in the vestry. The whole of the work was carried out by Mr. Shenton's department, under his personal direction.

For the above particulars we are indebted to the British Thomson-Houston Co., Ltd., by whom the lamps and reflectors used in the installation were manufactured.

View showing lighting St. Marie's Church, Rugby.

INDEX, December, 1921.

GAS IN THE UNITED STATES.

A survey completed by the American Gas Association, says the *Intercolonial Gas Journal*, shows in a striking manner the growth of this industry. Gas now furnishes the cooking heat and in many cases illumination in the homes of over 49 million citizens. Communities served with gas number 4,600, and meters 8,580,000, the gasmains totalling 68,300 miles. There are now 7 million gas-burning cooking appliances in American homes, gas water-heaters numbering approximately 1,500,000, and gas heaters 1,000,000. About 25 per cent. of the national consumption is now by manufacturing concerns, and over 1,200 different applications are on record.

ROYAL SANITARY INSTITUTE.

33rd Congress and Exhibition.

The Royal Sanitary Institute have accepted an invitation from the Mayor and Town Council of Bournemouth to hold their 33rd Congress and Exhibition in that town from July 24th—29th, 1922.

Further particulars may be obtained on application to the Secretary, Mr. E. White Wallis, 90, Buckingham Palace Road, London, S.W.1.

SIXTY YEARS OF ELECTRICAL PROGRESS.

In its Diamond Jubilee Number, issued on November 11th, the *Electrician* celebrates the termination of sixty years of progress. The history of the journal during this period is chiefly the history of a great change, both in technical journalism and in electrical engineering In 1861, when the journal started, only candles, oil lamps and flat flame burners were available for lighting; trams and motor omnibuses were unknown, and it took weeks to communicate with America and India, owing to the absence of telegraphic facilities. There were no half-penny papers and few technical journals.

All the marvellous changes subsequently arising from the continued practical developed applications of electricity have been in due course recorded by our contemporary, to whom we wish continued prosperity in the future.

From November 1st, 1921, onwards, the registered offices of **Messrs. English Electric and Siemens Supplies, Ltd.,** were transferred to 38-39, Upper Thames Street, London, E.C.4, and all communications should be sent to this address.

REVIEWS OF BOOKS.

Who's Who in Engineering. Second Edition, Edited by J. E. Sears, C.B.E., M.A. (*Issued from* 93-94, *Chancery Lane.* 31s. 6d. *net.* 757 *pp.*)

THE second edition of this useful work has been considerably extended and improved. It is now divided into three sections respectively, personal and professional, devoted to engineering firms, and institutions, societies, research organisations, technical journals, etc. A useful feature in Parts I. and II. is the classified list, from which persons or firms associated with various kinds of work may be selected. The final section includes a list of associations of manufacturers and employers. *Who's Who in Engineering* has satisfied a distinct want and is already a valuable work of reference, though we note that further improvements are contemplated in the next edition.

The Practice of Electric Wiring. By D. S. Munro. (*Electrical Review, Ltd., London.* 5s. *net.* 1921. *pp.* 267. *Figs.* 97.)

THIS book is essentially technical in its scope, *i.e.*, it aims at providing information of service to engineers, architects and others professionally concerned with electric wiring. After a brief historical introduction the author follows familiar lines in dealing successively with methods of distribution, wires and insulation, joints, casing and tubing, switches, etc. There are also useful chapters on procedure in erecting, temporary and portable wiring, and specifications, and the information is conveyed in a practical way. The work is completed by chapters dealing with special subjects, such as the wiring of mines and ships. The revised edition brings details up to date, and the author's constant insistence on conscientious methods will be endorsed by consulting engineers and others who know the consequences of negligent work.

Das Kugelphotometer. By Dr. Ing. R. Ulbricht. (*R. Oldenbourg, Munich.* 1920. *pp.* 110, 34 *illus. Mk.* 24.)

THE book consists essentially of a summary of Dr. Ulbricht contributions on the subject of the globe-photometer, comments on more recent developments being added. An introductory section sets out in chronological order the author's various researches and the experiments of other workers (Sumpner, Blondel and others). In later chapters the various sections of this work are developed in detail. Thus we have first an analysis of the theory of the apparatus, then discussions of the effect of foreign bodies within the globe, the influence of screens, the observation-window, the nature of the inner white coating, etc. The prescriptions for applying the coating, for which zinc white is recommended, were determined by a Committee of the German Illuminating Engineering Society in 1915, and are set out in detail. Some difference of opinion seems now to exist regarding the value of methods of measurement using only one half of the sphere; Dr. Ulbricht prefers the original plan of enclosing the source within a complete enclosing sphere. Reference is made to the propositions that have been made for using a more conveniently constructed shape of integrating photometer—*e.g.*, a cubical box. Various reasons are adduced for presuming that the order of accuracy must be less with any shape that departs materially from a spherical form.

It is remarked that whereas the Globe photometer was originally adopted in Germany for testing arc lamps, it has since been rapidly developed in the United States for use with incandescent lamps (largely owing to the general recognition of the desirability of measuring mean spherical candlepower). Dr. Ulbricht's work should be of considerable interest to all concerned with the practical development and use of the globe photometer.

Electrical Installation Rules and Tables. By W. S. Ibbetson. (*E. & F. N. Spon, London,* 1922. 1s. 6d.)

THIS little book of tables approaches the limit in compactness, being only 2¾ ins. by 2 ins., and easily inserted in a waistcoat pocket. It contains useful memoranda and should be of service to contractors and engineers.